Sandstone Precinct,

23-39 Bridge Street, Sydney

Predicted NABERS Energy Assessment Report

Prepared for: Essence Project Management

Attention: Ben Adams

Date: 11 February 2022

Prepared by: Jason Lei / Lachlan Finn

Ref: 301350567

Stantec Australia Pty Ltd
Level 6, Building B, 207 Pacific Highway, St Leonards NSW 2065
Tel: +61 2 8484 7000 Web: www.stantec.com

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Stantec

Revision

Revision	Date	Comment	Prepared By	Approved By
01	03/02/2022	Issue for Independent Design Review	JAL	LAF
02	09/02/2022	DRAFT for Comment	JAL	LAF
03	11/02/2022	Issue to DPIE	JAL	LAF

Qualifications to this Report

The following qualifications apply to this report:

- Information has been based on our understanding of the available documentation provided, as noted.
- Changes in System design and operation arising from fitout changes are not considered in this NABERS Energy Report.

Disclaimer

This energy model provides an estimate of the hotel development's energy performance. This estimate is based on a necessarily simplified and idealised version of the buildings that does not and cannot fully represent all of the intricacies of the building and its operation. As a result, the energy model results only represent an interpretation of the potential performance of the hotel development. No guarantee or warranty of building performance in practice can be based on energy modelling results alone.

The results generated from this analysis are based on specific criteria outlined in the NABERS Handbook for Estimating NABERS rating and are not considered to be a true representation of the actual operation of the building. The intent of these criteria is to permit the predicted outcome of a NABERS energy rating.

File Records

For records, the files used in this report are as follows:

IES Thermal Models:

- 29212_ALL_05_Exclusive.mit

ApacheHVAC File:

- 29212_NABERS_025_E.asp

Apache Vista File:

- 29212_NABERS_025_E.aps

Results File:

- 29212_NABERS Spreadsheet_008.xlsm

PREPARED BY:

Jason Lei
Sustainability Engineer
Stantec Australia Pty Ltd

APPROVED BY:

Lachlan Finn
Sustainability Section Manager
Stantec Australia Pty Ltd

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1. Executive Summary

This energy performance prediction sets an energy target for the Sandstones Precinct of 250kWh/yr/m^2. This is within 2% of the City of Sydney (CoS) draft hotel energy targets for 2023, 245 kWh/yr/m^2.

This is equivalent to a 2 Star NABERS rating against a Hotel Quality 5 Star benchmark, however this hotel is a Hotel Quality 6 Star development and no relevant NABERS benchmark data is available for comparison. The overall consumption is some 40-50% below adjusted benchmarks produced for Australian Hotels for "Very Good" (Highest benchmark) hotel energy performance within the *Energy Wise Hotels Toolkit December 2007,* and similarly 40-50% below adjusted benchmarks within the European Commission's *Best Environmental Management Practice in THE TOURISM SECTOR 7.1.*

To demonstrate performance that meets CoS objectives for energy efficiency the proponent proposes that following 12 months of operation that any shortfall against the CoS benchmark is met by the acquisition and retirement of LGC's or entering into a Power Purchase Agreement for renewable energy (5 years). This gap is illustrated below:

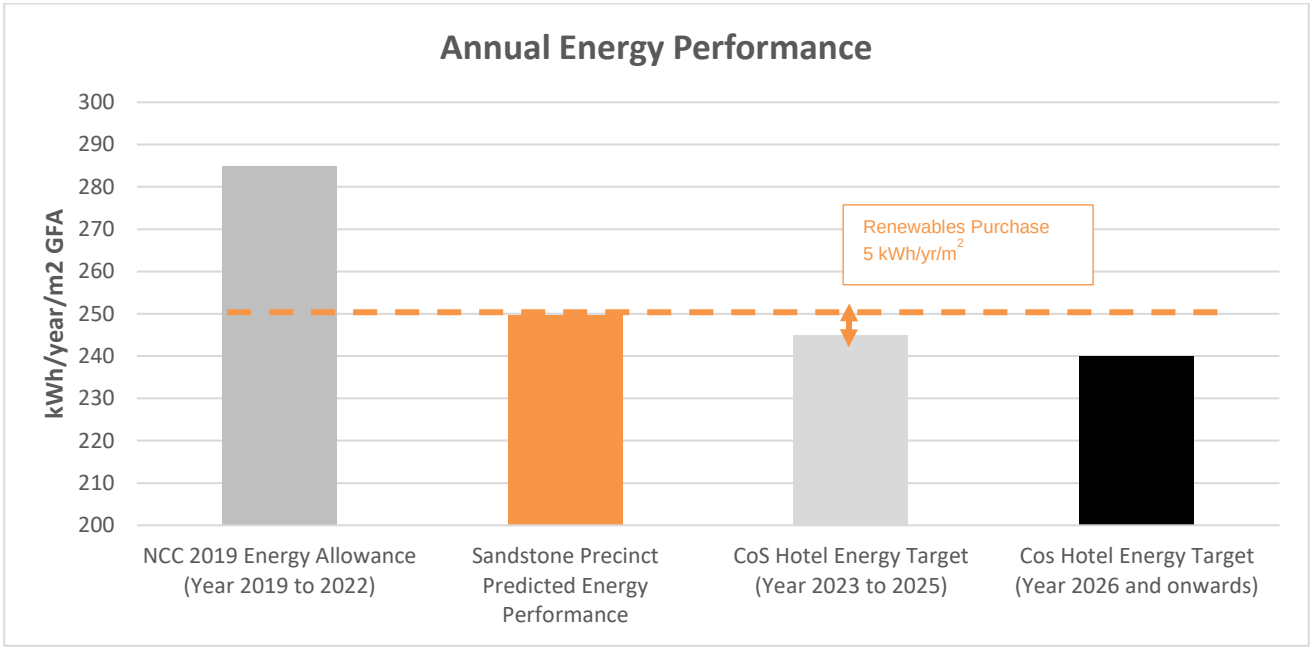


Figure 1: Comparison of Sandstones Precinct predicted energy performance and current benchmarks

The City of Sydney energy efficiency pathway is proposed given the following issues in relation to a NABERS Rating:

- This is a premium luxury hotel development with a 6 Star Hotel Quality rating, for which there are no precedents nor NABERS benchmarks
- Exceptionally low key count for the size of the development, including zero hotel keys in the Department of Lands building, where NABERS benchmarks are based on key counts. The average hotel key room size is 50m^2, compared to a hotel typical 25m^2. These room sizes are designed to minimize impact on and celebrate the heritage fabric of the Sandstones Precinct.
- Onsite renewables are not consistent with conservation objectives, so offsite renewables are proposed – however offsite renewables are not permitted in the NABERS Commitment Agreement process.
- Adaptive reuse of significant heritage items in the Sydney public domain, retaining a vast majority of fabric without intervention – prohibiting opportunities to uplift thermal performance.
- Adaptive reuse and retention of the vast majority of the existing fabric without intervention has a significantly lower environmental footprint associated with construction and material embodied carbon compared to a new build hotel

construction project. However, embodied energy savings are not considered in the NABERS and City of Sydney benchmarks.

The design provides for exceptional energy efficiency even within the constraints of heritage conservation. Innovative and ambitious energy efficiency measures include:

- High performance façade systems are equivalent to the energy performance of NCC 2019 Amdt 1, though the facades were designed and procured under NCC 2016 Amdt 1
- High efficiency central mechanical services plant serves both buildings in the precinct
- Heat recovery is provided from a low load chiller to serve hotel hot water use
- Chillers, pumps and cooling towers have a proprietary economiser installed which harmonises controls and equipment operation for maximum system-wide efficiency

The minimum benchmark at which NABERS will agree to a NABERS Commitment Agreement is 4 Stars. As NABERS will not allow a commitment agreement of 2 Stars, this report and Independent Design Review follow the structure of a NABERS Commitment Agreement only for the purposes of comparison and assessment by the Department of Planning, Industry and Environment. The NABERS Commitment Agreement will not be officially entered into due to the incompatibility of NABERS Hotel Energy with the Sandstones Precinct development.

Predicted energy performance modelling has been undertaken with the detailed independent review by Ian Gardner of Napier & Blakeley (NABERS Independent Design Review Panel), his findings that this is estimate meets the requirements of the NABERS Handbook for estimating energy consumption are included in the appended NABERS IDR Report.

1.1 NABERS Energy Outcomes – Reference Case

A breakdown of the energy consumption (Reference Case) for the hotel development is listed below:

Table 1 – Reference Case Energy Use

Description	Electricity (kWh/annum)	Gas (MJ/annum)	Energy Use Intensity (kWh/m2 GFA)	Energy Percentage Breakdown
Heating (Boilers)	-	3,338,809	38.31	15.7%
Cooling (Chillers)	193,799	-	8.00	3.3%
Heat Rejection (Cooling Tower, Condensing Unit, and CDW Pumps)	163,079	-	6.74	2.8%
AHU & FCU Fans	610,015	-	25.19	10.3%
HHW & CHW Pumps	234,441	-	9.68	4.0%
CRAC Units	59,687	-	2.47	1.0%
Ancillary Ventilation Fans	676,168	-	27.93	11.4%
Vertical Transportation	73,039	-	3.02	1.2%
Artificial Lighting - Internal	808,814	-	33.41	13.7%
Artificial Lighting - External	25,726	-	1.06	0.4%
Domestic Hot Water	-	1,598,747	18.34	7.5%
Hydraulic Pumps	117,536	-	4.85	2.0%
Misc. Loads	36,318	-	1.50	0.6%
Kitchen Equipment	360,000	1,026,000	26.64	10.9%
Guest Room Equipment	258,839	-	10.69	4.4%
Common Area Equipment Loads	266,333	-	11.00	4.5%
Swimming Pool Heating	-	910,356	10.44	4.3%
Swimming Pool Pumps	119,645	-	4.94	2.0%
Total Energy Use	**4,003,438**	**6,873,912**	**244.21**	**100.0%**
Total GHG Emissions	**4,047,356 kgCO2-e/year**			
NABERS Score	**2 Star NABERS + 59.6%% Improvement**			

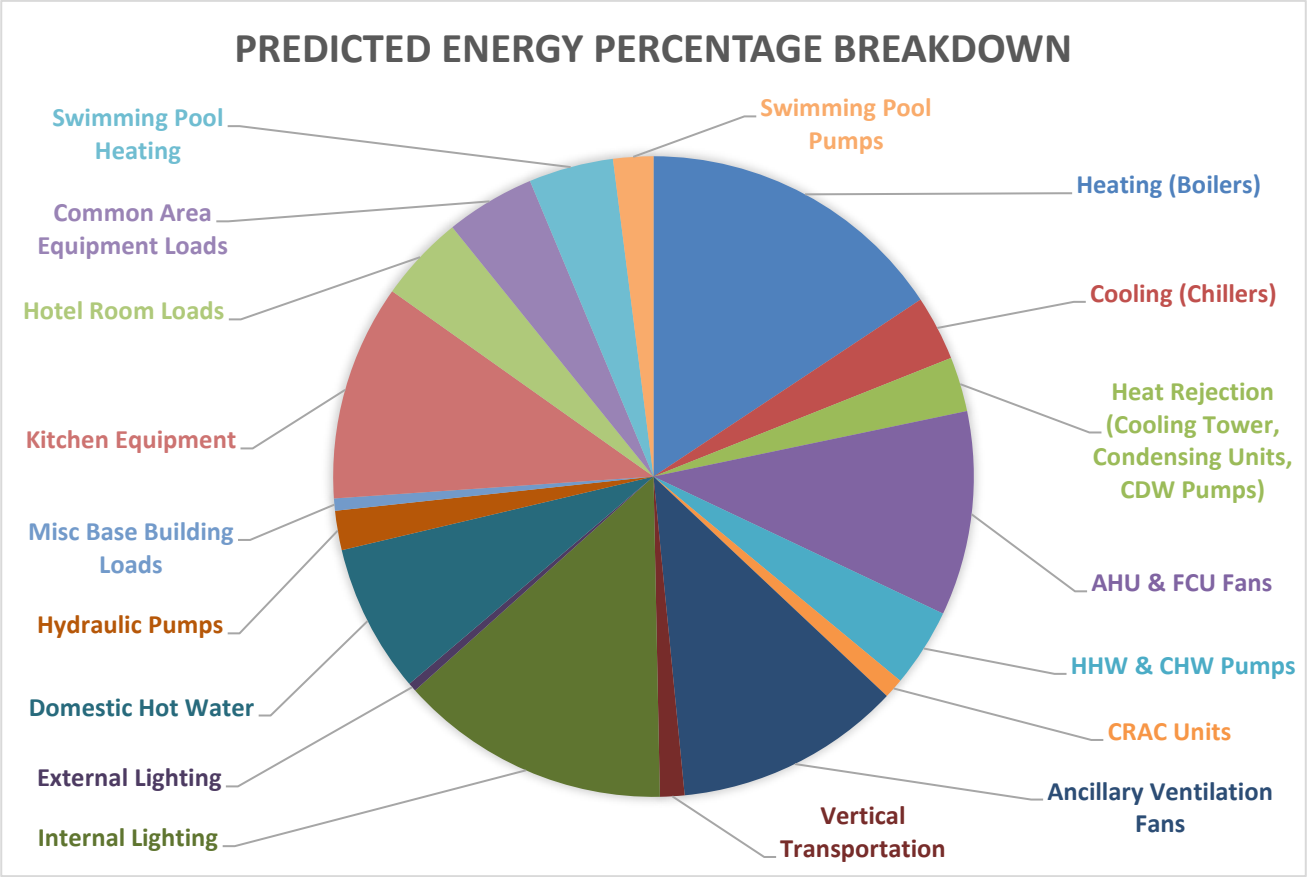


Figure 1 – Predicted Energy Percentage Breakdown for Sandstone Precinct development

1.2 Off-Axis Scenario Case

Off-axis factors were modelled to assess effects of the building operating away from the design condition, such as:

1. 100% occupancy level (i.e. no occupancy diversity factors applied).
2. Simulate with 2030 predicted weather file for the impact of climate change.
3. Increased food coverage resulting in increased kitchen equipment energy use
4. No CO2 sensor controls to the ancillary ventilation fans to the Lands Building function spaces

A breakdown of the energy consumption for the hotel development is listed below. Items highlighted in yellow signify the energy consumption changes with respect to the off-axis factors.

Table 2 – Off-Axis Scenario Energy Use

Description	Electricity (kWh/annum)	Gas (MJ/annum)	Energy Use Intensity (kWh/m2 GFA)	Energy Percentage Breakdown
Heating (Boilers)	-	2,228,763	25.57	10.2%
Cooling (Chillers)	279,695	-	11.55	4.6%
Heat Rejection (Cooling Tower, Condensing Unit, and CDW Pumps)	185,727	-	7.67	3.1%
AHU & FCU Fans	647,018	-	26.72	10.6%
HHW & CHW Pumps	232,801	-	9.62	3.8%
CRAC Units	77,455	-	3.20	1.3%
Ancillary Ventilation Fans	689,473	-	28.48	11.3%
Vertical Transportation	73,039	-	3.02	1.2%
Artificial Lighting - Internal	808,814	-	33.41	13.3%
Artificial Lighting - External	25,726	-	1.06	0.4%
Domestic Hot Water	-	1,713,896	19.66	7.8%
Hydraulic Pumps	117,536	-	4.85	1.9%
Misc. Loads	36,318	-	1.50	0.6%
Kitchen Equipment	480,000	1,368,000	35.52	14.2%
Guest Room Equipment	307,988	-	12.72	5.1%
Common Area Equipment Loads	266,333	-	11.00	4.4%
Swimming Pool Heating	-	910,356	10.44	4.2%
Swimming Pool Pumps	119,645	-	4.94	2.0%
Total Energy Use	**4,347,567**	**6,221,015**	**250.93**	**100.0%**
Total GHG Emissions	**4,314,875 kgCO2-e/year**			
NABERS Score	**2 Star NABERS + 2.6%% Improvement**			

2. Introduction

2.1 Project Overview

Stantec have conducted an energy simulation estimation for the Sandstone Hotel Precinct (including both Education Building and Lands Building) development to predict its potential combined precinct energy performance.

The purpose of this predicted energy performance assessment is to establish the Sandstone Precinct's energy benchmark to support the proposed SSD-7484-MOD13 DA conditions modifications. The intent of this target is to be ambitious in the context of current planning provisions, but achievable within the constraints of the heritage fabric. The gap between this target and City of Sydney 2023 Hotel Energy target is proposed to be met through Green Power purchase, LGC's or similar arrangement.

The Sandstone Precinct development involves the refurbishment of two existing heritage buildings (namely, the Education Building and Lands Building) along 23-39 Bridge Street, Sydney NSW 2000. The precinct is to be refurbished as a 6-star luxury hotel development, with the Education Building being a hotel accommodation (holding 192 room keys) supported by the Lands Building comprising of hotel amenities and non-hotel use tenancies.

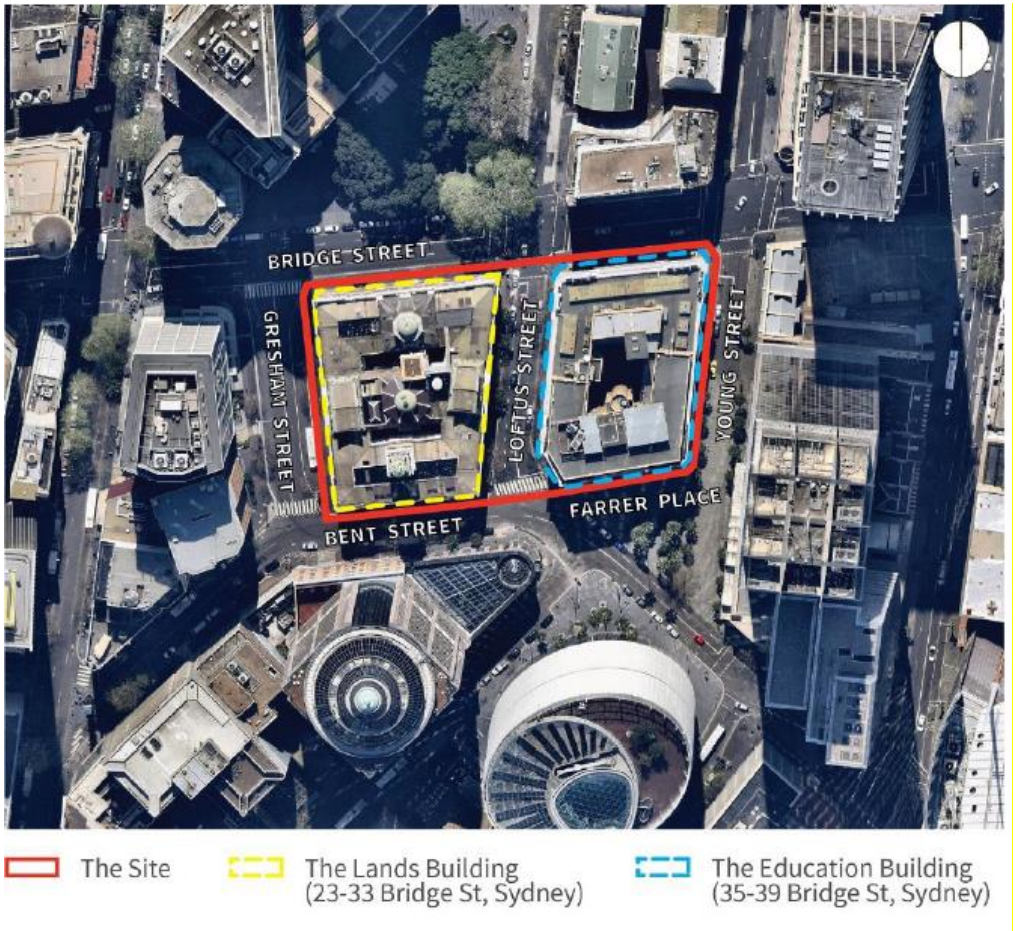


Figure 1 – Site Location

Education Building consist of:

- 3 basement floors for central plant room, services and back of house (BOH). Bottom-most floor is connected to the Lands Building via a tunnel link carrying services and BOH access;
- Lower-ground & Ground level composed of lobby, hotel amenities, BOH, and destination bar tenancy;
- Nine-storeys of hotel guestrooms (From Level 1 up to Level 9, with Level 6 to Level 9 being new floors introduced above the existing heritage building); and

- Level 5 contains pool, spa and gym facilities;

Lands Building consist of:
- Lower-ground, Ground and First floors are made up of food and beverage, retail and co-working tenancies external to the hotel
- Three-storeys of hotel amenities, functions and services (From Level 2 up to Level 4) including bars, dining rooms, lounge rooms, meeting rooms, library, functions, wellness facilities, etc.

2.2 Modelling Methodology

A detailed 3-dimensional dynamic model of the building was produced utilising the Integrated Environmental Solutions (IES) Virtual Environment building simulation software package. The latest available architectural information available was used in determining building layout, orientation, extent of glazing, etc. The specific building constructions, heating, ventilating & air conditioning (HVAC) systems, occupancy, lighting and controls were modelled in accordance with the expected installation and the NABERS Validation Protocols for Computer Simulations. Details of the modelling process and inputs are described in Sections 4 and 5 of this report.

2.3 Protocols

The information provided in this report is in accordance with the following validation protocols:

- NABERS Handbook for Estimating NABERS Ratings Version 2.0 (September 2021)
- Guidelines for Conducting an Energy Efficiency Design Review (June 2011)
- Guidelines for the use of simulation in Commitment Agreements (June 2011)

2.4 Disclaimer

The NABERS scheme is based on the operational history of the building. The predictive NABERS rating is validated following 12 months' operation. It is only at this point an official rating is given. The intention of predicted analysis is to provide effective comparison of options and reduce the risks associated with achieving the required target.

It is essential to understand that this report outlines a predictive NABERS analysis, based on the building design and the NABERS protocols and assumptions discussed in this report. The results of the analysis do not guarantee the required outcome. The level of discrepancy between the predicted rating and the actual rating achieved after a minimum of one year's operation will depend on several factors including:

- The standard of commissioning of the installed services
- The design of the tenant fit-out including the resulting load imposed on the base building air conditioning
- The operation and maintenance of the building and its installed plant and equipment
- Tenant/operator behaviour

Refer to NABERS Brand Guidelines (June 2008) and the NABERS Energy Commitment Agreement (Fact Sheet 7) for details regarding use of NABERS trademark.

The potential performance of a building can be 'predicted' through the use of detailed computer simulations. The simulations must be performed in accordance with the appropriate NABERS protocols. The predictive analysis is intended to quantify the potential performance only and it must be recognized that the actual performance may vary depending on the management and operation of the building. Any given predictive rating for a building is only officially recognized after validation of the actual operational energy consumption data for a continuous 12-month period.

3. NABERS Energy Overview

3.1 NABERS Hotel Rating Benchmarks

NABERS Commitment Agreement is not available to projects with predicted ratings of less than 4 Stars. This report has been prepared in the format of a NABERS Commitment Agreement Energy Assessment to meet the planning assessment criteria of the Department of Planning, Industry and Environment only.

NABERS Hotel Energy Rating benchmarks the performance of a proposed or actual hotel building. NABERS Hotel Energy rates hotels based on all energy uses including electricity and gas consumption. This is normalised based on equivalent emissions of kilograms of carbon dioxide per room ($kgCO_2e$/room) per year.

Ratings are benchmarked based on the use of stars as indicative measurements of performance. The following hotel building consumption limitations are applied to determine the applicable star rating for Sydney, Postcode 2000:

Table 1: NABERS Star Bands for Sydney, Postcode 2000

NABERS Hotel Energy Star Rating	Maximum Normalised GHG Emissions ($kgCO_2e$ per room/year) Scope 1, 2 & 3
6	3,934
5	7,868
4	12,757
3	17,647
Sandstone Precinct	**21,080**
2	22,537
1	27,426

The Sandstones Precinct exceeds the 2 Star benchmark, and is equivalent to a **2.3 Star** NABERS Hotel Energy rating.

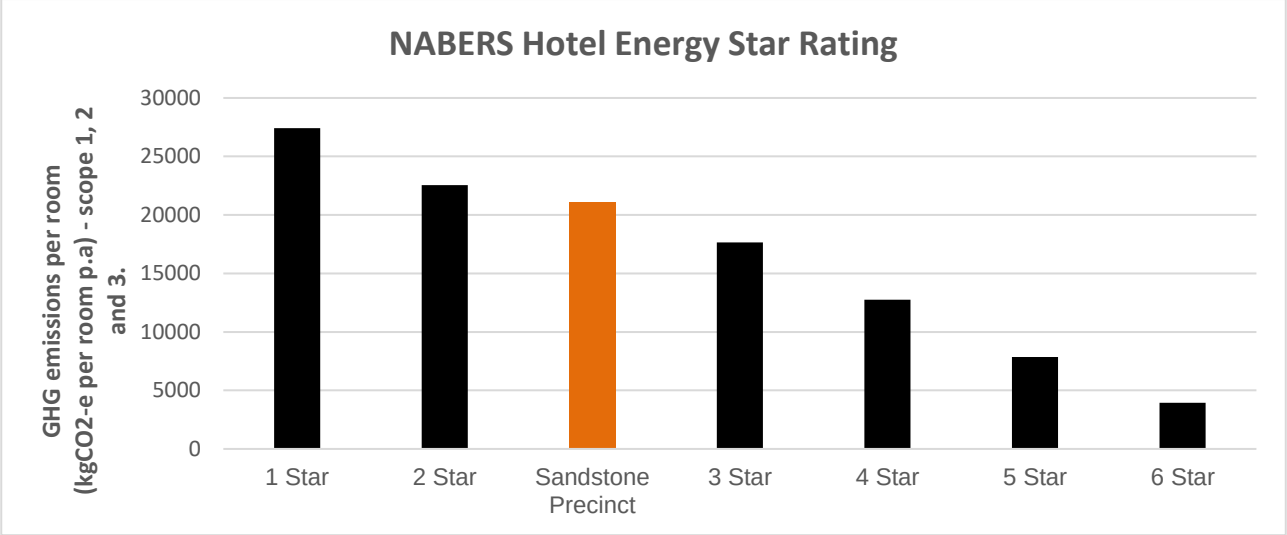


Figure 2: NABERS Hotel Energy Star Rating Benchmarks

3.2 NABERS Hotel Inputs

The NABERS Hotel Energy rating benchmarks are established based on the following critical inputs:

Table 2: NABERS Energy Hotel Rating Inputs

NABERS Hotel Energy Inputs	Inputs
Building Postcode	2000
Hotel Star Rating	5.0*
Number of Rooms in the Hotel	192
Number of Rooms with Full Service Laundering	0
Number of Function Room Seats	679
Surface Area of Heated Pools (m2)	115

* Note that the NABERS Energy for Hotels system does not have a benchmark for 6 Star hotel quality ratings so a 5 Star rating is being used in its place.

3.2.1 Heated Pools Surface Area

Table 3 presents details of the heated swimming pools comprising a 100 sqm Lap Pool and 15 sqm of spas (namely, Vitality Pool).

Table 3: Swimming Pool Surface Dimensions

Swimming Pool	Surface Area of Heated Pool (m2)	Pool Volume (m3)
Lap Pool	100	120
Vitality Pool	15	12.75
TOTAL	**115**	**132.75**

3.2.2 Number of Laundered Rooms

The hotel intends to outsource all laundry of bed sheets and towels. As such, there are no internal guest room serviced by the on-site laundry.

3.2.3 Function Room Seats

Table 4 outlines the total number of function room seats (maximum seating capacity) of all conference/function/meeting/ballrooms or similar that are available for hire by the general public for meetings and functions. This does not include seats within on-site hotel restaurants nor seats within function rooms that are not part of rated area under the NABERS Hotel Energy rating.

Table 4: Function Room Seat Counts

Location	No. of Seats
Education Building – Ground Floor	132
Lands Building – Level 2	417
Lands Building – Level 3	72
Lands Building – Level 4	58
TOTAL	**679**

4. Modelling Software and Weather Data

4.1 Software Package Used

The computer simulations in this report are performed using the IES Virtual Environment version 2019.3.1.0 modelling software.

This software package is capable of performing dynamic thermal simulations and has been tested in accordance with ANSI/ASHRAE Standard 140-2004. 'Building envelope and fabric load tests performed on ApacheSim in accordance with ANSI/ASHRAE Standard 140-2004' and 'HVAC load tests performed on ApacheSim in accordance with ANSI/ASHRAE Standard 140-2004'. A letter confirming the software has been tested in accordance with ASHRAE has been provided in the appendix of this report. The whole testing document has not been included due to its volume, but is available from the software supplier upon request.

To assess the building's energy and thermal comfort, the modules used for simulation include ModelIT, Suncast, ApacheHVAC and ApacheSim. The ModelIT module in IES provides the facility for developing the three-dimensional model of the building including the specifications of the construction types, inputs of site location and ambient weather data. Once the model is developed, Suncast is used to provide an estimation of the solar loads that the building experiences in a typical year. This solar analysis includes the effects of the shading devices as well as shading effects of nearby buildings casting onto the building of interest. ApacheHVAC is a highly flexible module used for the generation of a model for the actual HVAC system on site.

ApacheSim is a dynamic thermal simulation program based on first principles mathematical modelling of the heat transfer processes occurring within and around a building. The program provides an environment for the detailed evaluation of building and system designs, allowing them to be optimised with regard to comfort criteria and energy use. Within ApacheSim, conduction, convection and radiation heat transfer processes for each element of the building fabric are individually modelled and integrated with models of room heat gains, air exchanges and HVAC plant. The simulation is driven by simulated weather data. The time-evolution of the building's thermal conditions is traced at intervals as small as a minute. ApacheSim uses a *stirred tank* model of the air in a room. This means that the calculations are based on the concepts of bulk air temperature and humidity, which are assumed to be uniform within the room. Further information on the calculation methods can be found in the software's manual, which will be available upon request.

4.2 Weather File

The Sydney Observatory Hill Test Reference Year (NSW_Sydney_RO_81_TRY.fwt) weather file has been used for the reference case scenario, as provided by ASHRAE for design conditions. This is the closest available to the site and meets the requirements of being within 50km of the actual site. The details of this weather file are included in Appendix B.

The Year 2030 Ersatz Future weather file (EFMY) for the location of Observatory Hill, Sydney has been used for the off-axis scenario to assess the risk associated with the climate change on building energy performance. The future weather file's data is based on a CSIRO report which provides projected seasonal and monthly changes values for 2030 and 2050 for low (B1), mid-range (A1B) and high (A1FI) worldwide greenhouse gas and aerosol emission scenarios (*Sources from "Exemplary Energy Partners" website.)*. The EFMY weather file used to simulate the off-axis scenario for this project represents the 'Year 2030 Mid Emissions Warmest Likely (model A1B)' whereby the term 'Warmest Likely' indicates 'worst case' as being the greatest change to the climate system.

5. Modelling Inputs

5.1 Input Validation

In accordance with the NABERS protocol – Energy Guide to Building Energy Estimations the following validation form has been provided. It summaries the input data utilized in the model.

Table 5: Inputs Validation Form

Item	Description
Climate Data	Refer to Appendix B for details of the weather data used for the simulation of the site
Building Form	Building form has been entered as per Architectural plans provided. Refer to Section 5.3 for details of the building form and the Architectural drawings.
External Shade	The external shade has been entered as per the surrounding buildings. Refer to Section 5.3.3
Glazing	The extent and performance of the glazing has been modelled as per the building design. Refer to Section 5.3.5 for details of the performance data used in the simulation
Insulation and Façade	The extent and performance of the insulation has been modelled as per the detailed building fabric design and Section J report by Stantec. Refer to Section 5.3.5 for details of the performance applied.
Floor Area	The floor area has been calculated per the Architectural GFA Schedules provided. Refer to Section 5.3.4.
Lighting Power Density	Refer to Section 5.4.1 for lighting power density inputs and energy calculations.
Lighting Hours	Refer to Section 5.4.2 and Appendix C for details of lighting hours of use used in the modelling.
Lighting Controls	Refer to Section 5.4.2 for details of lighting control use used in the modelling.
Equipment Density	Refer to Section 5.4.1 for details of equipment power density inputs used in the modelling.
Equipment Hours	Refer to Section 5.4.2 and Appendix C for details of equipment hours of use used in the modelling.
Occupant density	Refer to Section 5.4 and Appendix C for occupancy density inputs and energy calculations.
HVAC System Type	Education Building: Air Handling Units provided 100% preconditioned outside air to the building. Local Chilled Water Fan Coil Units for hotel guestrooms and ancillary zones. Lands Building: Air Handling Units and Fan Coil Units for ancillary zones. Refer to Section 5.7.1 and Appendix D for details of HVAC System Type
HVAC Hours	Refer to Section 5.4.2 and Appendix C for HVAC profiles.
HVAC After Hours	N/A
HVAC Plant	Cooling is provided by two (2) Water-cooled high load chillers and (1) water-cooled low load heat-recovery chiller with three (3) Cooling towers. Heating is provided by two (2) condensing boilers. Refer to Section 5.7 and Appendix D for details of HVAC Plant System
HVAC Control	Per mechanical specification and BMCS Specification. Refer to Section 5.7, Appendix D and Appendix E
Infiltration	Refer to Section 5.5 for infiltration values for modelled conditioned zones.
DHW Load	Modelled based on predicted hot water usage calculations. Refer to Section 5.10.1
Lifts & Escalators	Refer to Section 5.11 for details of lift parameter inputs used in the modelling

Energy Coverage	Education Building: Whole Building except Lower Ground – F&B Retail (Room E.LG.GE35) Lands Building: Whole Building except for tenancies operated by third parties (i.e. retail, tenant kitchens, and co-working spaces) from Lower Ground up to Level 1. Refer to Appendix H for mark-up of spaces excluded from NABERS Hotel Energy rating.
Document Referencing	Refer to Appendix A for a full list of referenced documents.

5.2 Energy Calculation Methods

Table 6 outlines the energy estimation method applied to each energy use components.

Table 6: Energy Calculation Method

Item	Description
Heating (Boilers)	Modelled within IESVE ApacheHVAC under a dynamic simulation
Cooling (Chillers)	Modelled within IESVE ApacheHVAC under a dynamic simulation
Heat Rejection (Cooling Tower, Condensing Units)	Modelled within IESVE ApacheHVAC under a dynamic simulation
AHU & FCU Fans	Modelled within IESVE ApacheHVAC under a dynamic simulation
HHW & CHW Pumps	Modelled within IESVE ApacheHVAC under a dynamic simulation
CRAC Units	Modelled within IESVE ApacheHVAC under a dynamic simulation
Ancillary Ventilation Fans	Calculated in spreadsheet analysis using mechanical schedules
Vertical Transportation	Calculated in spreadsheet analysis using vertical transport details
Artificial Lighting - Internal	Calculated in spreadsheet analysis using lighting layouts and NABERS lighting schedules
Artificial Lighting - External	Calculated in spreadsheet analysis using lighting layouts and typical hours of use
Domestic Hot Water	Calculated in spreadsheet analysis using DHW system details and estimated potable water use
Hydraulic Pumps	Calculated in spreadsheet analysis
Misc. Loads	Calculated in spreadsheet analysis with allowance of 1.5kWh/m2 GFA
Kitchen Equipment	Calculated in spreadsheet analysis using NABERS default kitchen energy consumption with real data of typical food coverage for similar luxury star rated hotels
Guest Room Equipment	Calculated in spreadsheet analysis using NABERS default hotel equipment loads and NABERS hotel equipment schedule
Common Area Equipment	Calculated in spreadsheet analysis
Swimming Pool Heating	Calculated in spreadsheet analysis using pool system details
Swimming Pool Pumps	Calculated in spreadsheet analysis

5.3 Building Form

5.3.1 Building Geometry

Figure 3 illustrates the extent of the three-dimensional (3D) model developed representing the Sandstone Precinct development along 23-39 Bridge Street, Sydney.

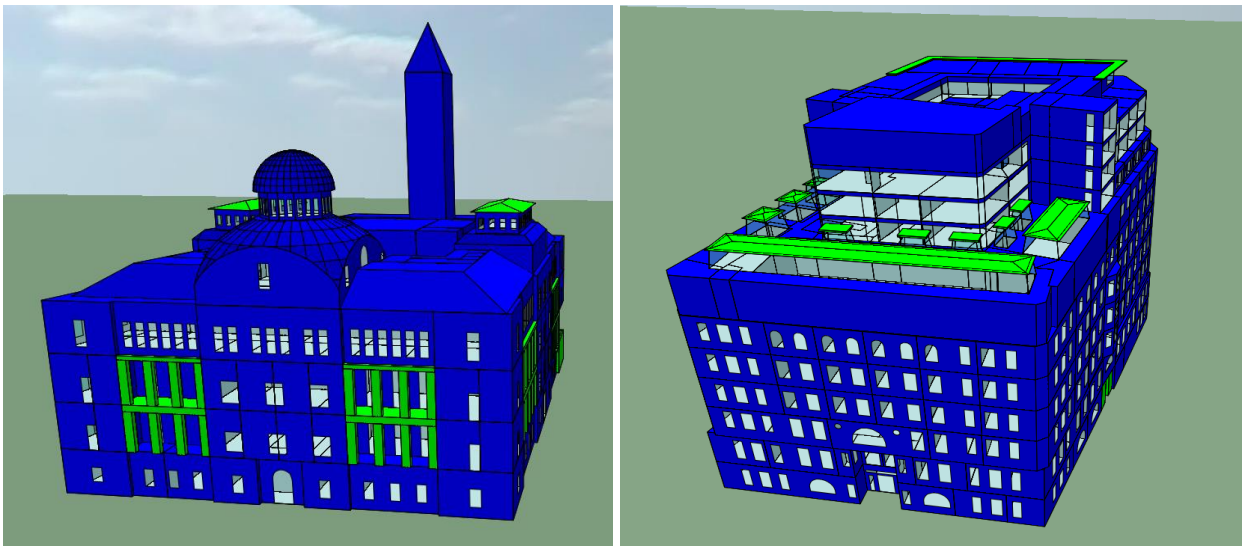


Figure 3: IES 3D Geometry (Left image – Lands Building; Right image – Education Building)

5.3.2 Orientation

Figure 4 illustrates the building orientation and local surroundings which has been captured in the model.

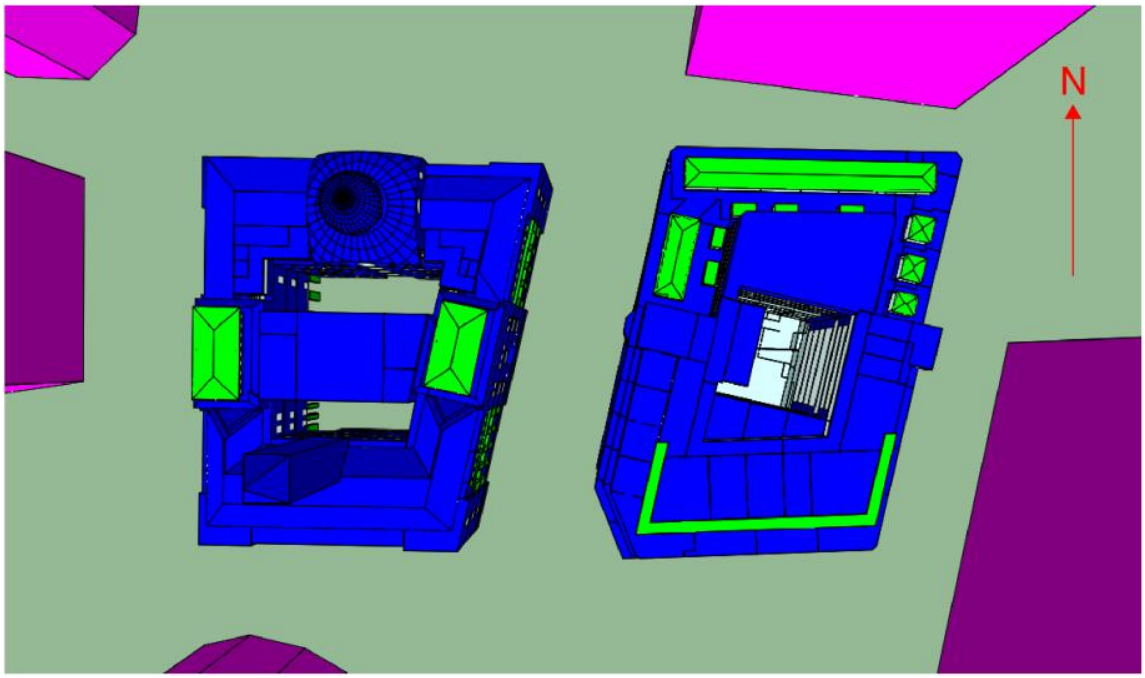


Figure 4: IES site plan showing orientation (Left of image – Lands Building; Right of image – Education Building)

5.3.3 Surrounding Buildings

The site is an existing hotel development located within the City of Sydney and has neighbouring building that vary in height and with some overshadow of the lower levels. To capture the effects of overshadowing, surrounding building were included in the model simulation as pink objects as shown in Figure 5

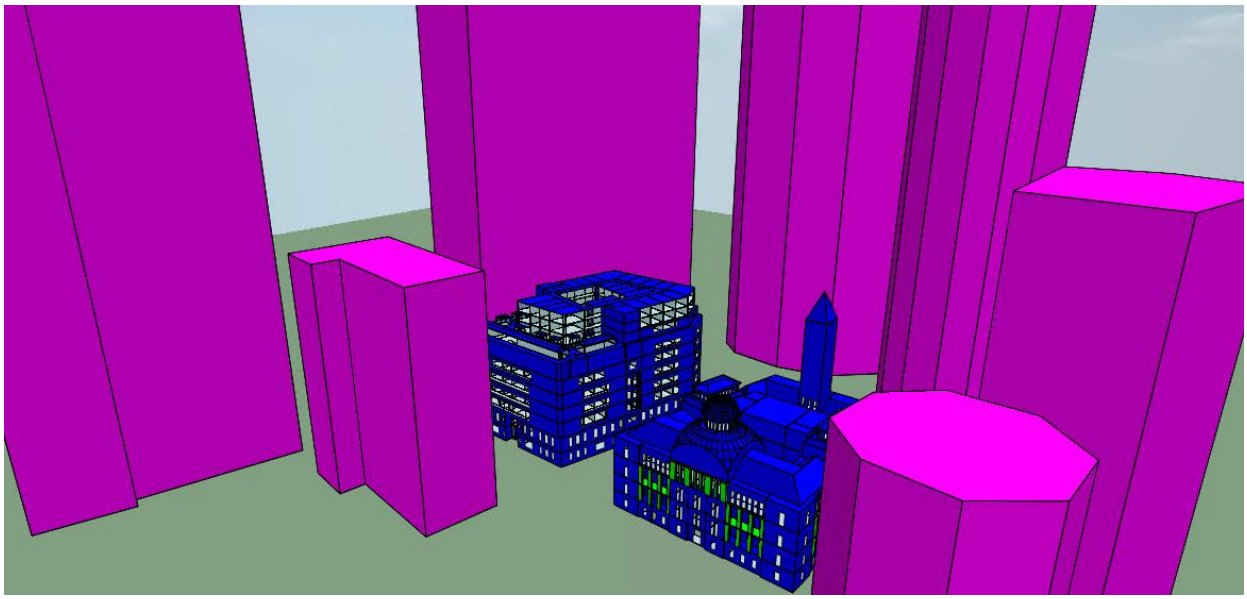


Figure 5: IES 3D View showing surrounding buildings in pink

5.3.4 Floor Area

Table 7 provides the Gross Floor Area (GFA) and Architectural information from the IES model.

Table 7: Sandstone Precinct Development Floor Area

Building	Modelled Spaces (m^2)	Architectural GFA (m^2)	Difference
Education	20,513	19,055	7.1%
Lands	10,673	9,935	6.9%
GFA Total	31,186	28,990	7.0%
Non-GFA (Plant, service etc)	6,105	5,678	7.0%
Grand Total	37,291	34,677	7.0%

The modelled conditioned area is greater than the architectural GFA as the energy modelling geometry includes for some spaces that do not appear in architectural GFA schedules, and the process of simplification removes some factors including wall thicknesses – which are significant in this project. The variation in modelled against architectural area is larger than usual in this project, but justified. The rated floor area is **28,993m2.**

The Gross Floor Area for each floor of the Education Building & Lands Building are tabulated below.

Education Building

Level	Gross Floor Area (m^2)	Rated Floor Area (m^2)
Basement 3	556	556
Basement 2	522	522
Basement 1	35	35
Lower Ground	1,600	1,287
Ground	2,223	2,223
Level 1	1,755	1,755
Level 2	2,075	2,075
Level 3	2,075	2,075
Level 4	2,069	2,069
Level 5	2,026	2,026
Level 6	1,282	1,282
Level 7	1,203	1,203
Level 8	1,206	1,206
Level 9	428	428
TOTAL	**19,055**	**18,742**

Table 8: Education Building – Area Summary

Lands Building

Level	Gross Floor Area (m^2)	Rated Floor Area (m^2)
Lower Ground	2,363	1,567
Lower Ground Mezzanine	300	300
Ground	2,027	317
Level 1	2,131	170
Level 2	2,045	2,045
Level 3	817	817
Level 4	252	252
TOTAL	**9,935**	**5,468**

Table 9: Lands Building – Area Summary

5.3.5 Construction

The construction of the building envelop has been represented based on the façade design. The following table lists the thermal properties and the constructions applied in the simulation. There are areas of reduction to these insulated values, which are highlighted in the architectural insulation set. These are predominately to beams and columns that cannot support insulation.

Education Building

The following building fabric and glazing construction have been used in the modelling of the Education Building

Table 10: Education Building Construction Thermal Performance used in the simulation

Building element	Total Construction Thermal Performance Requirements*
Roof & Ceiling Construction	New Roof/ceilings – Total System R-value of 3.2 Existing Roof/ceilings where retained and/or heritage listed – no added insulation
External Wall (non-spandrel)	New external walls (non-spandrel) – Total System R-value of 2.8 or 2.3 Existing sandstone external walls where retained and/or heritage listed – no added insulation
External Wall (spandrel)	New external walls (spandrel) – Total System R-value of 0.7
Internal Wall (between conditioned and non-conditioned zones)	New internal walls - Total System R-value of 1.8 Existing internal walls where retained and/or heritage listed – no added insulation
Exposed Suspended Floor (between conditioned and non-conditioned zones)	New suspended floors - Total System R-value of 2.0 Existing exposed floors where retained and/or heritage listed – no added insulation
Slab on Ground	None - no added insulation

*The Total R-value (RT) (m2K/W) means the sum of the R-values of the individual component layers in a composite element including any building material, insulating material, airspace, thermal bridging and associated surface resistances.

Table 11: Education Building Glazing Thermal Performance used in the simulation

Glazing element	Total System U-value*	Total System SHGC*
FTE02 – Level 2 Courtyard Skylight	6.1	0.76
FTE03 – Courtyard Glazing, from Level 2 to Roof	2.6	0.25
FTE05 – West/East Tower Glazing	2.6	0.40
FTE07 – Level 6 Re-built Modular Facade	3.1	0.55
FTE08 – Level 6, 7 and 8 New Build Facade	2.6	0.40
FTE09 – Level 9 New Build Facade	2.6	0.40
FTE12 – Existing heritage glazing with new secondary glazing	7.0	0.8
Level 5 Roof Lanterns	2.2	0.42

*The total system U-value and solar heat gain coefficient (SHGC) performance values above are for combined effect of glass plus frame in accordance with Australian Fenestration Rating Council (AFRC) requirements

Lands Building

The following building fabric and glazing construction have been used in the modelling of the Lands Building.

Table 12: Lands Building Construction Thermal Performance used in the simulation

Building element	Total Construction Thermal Performance Requirements*
Roof & Ceiling Construction	New Roof/ceilings – Total System R-value of 4.2 Existing Roof/ceilings where retained and/or heritage listed – no added insulation
External Wall (non-spandrel and spandrel)	New external walls – Total System R-value of 2.8 Existing sandstone external walls where retained and/or heritage listed – no added insulation
Internal Wall (between conditioned and non-conditioned zones)	New internal walls - Total System R-value of 1.8 Existing internal walls where retained and/or heritage listed – no added insulation
Exposed Suspended Floor (between conditioned and non-conditioned zones)	New suspended floors - Total System R-value of 2.0 Existing exposed floors where retained and/or heritage listed – no added insulation
Slab on Ground	None - no added insulation

*The Total R-value (RT) (m2K/W) means the sum of the R-values of the individual component layers in a composite element including any building material, insulating material, airspace, thermal bridging and associated surface resistances.

Table 13: Lands Building Glazing Thermal Performance used in the simulation

Glazing element	Total System U-value*	Total System SHGC*
All New Glazing	4.7	0.60
All New Roof Light Glazing (link between L3 Dome & Corridors)	8.5	0.83
All Existing Heritage Glazing	7.0	0.80

*The total system U-value and solar heat gain coefficient (SHGC) performance values above are for combined effect of glass plug frame in accordance with Australian Fenestration Rating Council (AFRC) requirements

5.4 Internal Loads & Profiles

5.4.1 Internal Load Densities

Table 14 summarises the internal load inputs based on the proposed design for the project that have been used in the HVAC simulation.

Table 14: Internal Load Modelling Inputs

Space	Lighting	Occupancy	Equipment
Hotel Guest Rooms	6 W/m2	1.6 people per room as per the Handbook for Estimating NABERS ratings	As per the Handbook for Estimating NABERS ratings: • 70W continuous for bar fridges; • 360W (inclusive of 160W for general misc. loads, 150W for

			TV and 50W for guestroom IT equipments).
Pool / Spa / Gym	10 W/m2	10 m2/person for Pool based on mechanical services design occupancy load 4 m2/person for Gym & Spa based on mechanical services design occupancy load	20 W/m2 for Gym 5 W/m2 for Pool and Spa based on mechanical services design occupancy load
Dining / Café / Restaurant	18 W/m2	2.5 m2/person	Mixture of 5 W/m2 to 15 W/m2 for dining / café / restaurant spaces based on mechanical services design occupancy load
Kitchen / BOH Kitchen	8 W/m2	10 m2/person	150 W/m2
Common Area & Bar	18 W/m2	3 m2/person	15 W/m2
Office / Meeting Room	7 W/m2	10 m2/person	11 W/m2
Function Room / Boardroom / Lounge	10 W/m2	2 m2/person	Function Room / Boardroom – 5 W/m2 Lounge – 150W per room
Lobby / Corridor / Circulation	8 W/m2	10 m2/person	5 W/m2

5.4.2 Profiles

The operational profiles used in the HVAC simulation are referred to the following documents by using the most suitable profiles for a given functional space. Refer to Appendix C for the profiles listed in table format and other assumed profiles not prescribed in the reference documents tabulated below.

Table 15: Operational Profile Modelling Input References

Description	Document References
Lighting	• Handbook for estimating NABERS ratings, Version 2.0, September 2021 • NCC 2019 Amendment 1, Section J – Specification JVc Modelling Profiles
Occupancy	• Handbook for estimating NABERS ratings, Version 2.0, September 2021 • NCC 2019 Amendment 1, Section J – Specification JVc Modelling Profiles
Equipment	• Handbook for estimating NABERS ratings, Version 2.0, September 2021
HVAC	• Handbook for estimating NABERS ratings, Version 2.0, September 2021 • NCC 2019 Amendment 1, Section J – Specification JVc Modelling Profiles • Mechanical BMCS Functional Description Report, Revision C, September 2020 prepared by Mitsubishi Electric for the Education Building

5.5 Infiltration

The following infiltration values were adopted for modelling conditioned zones:

Heritage Spaces:

- 0.5 air changes per hour at perimeter zones when HVAC is ON;
- 1.0 air changes per hour 1.0 when HVAC is OFF;

New Built:

- 0.35 air changes per hour at perimeter zones when HVAC is ON;
- 0.7 air changes per hour 1.0 when HVAC is OFF;

New build elements are expected to achieve a level of airtightness consistent with NCC 2019 requirements. Heritage elements are undergoing sealing for acoustic requirements and will have a higher degree of airtightness than existing conditions, but unlikely to meet the infiltration level of the new build elements.

5.6 Diversity

Operational building information for comparable sites and the same hotel operator were provided and used to understand the hotel occupancy rates associated with 6-star luxury premium hotels. Within the available dataset, occupancy rates for 6-star luxury premium hotels ranged from 35% up to 70%. For the Sandstones Precinct, a 70% diversity has been applied based on the upper extent of the observed occupancy range. This diversity factor has been applied to the hotel room energy consumption only.

5.7 Mechanical Services

5.7.1 Mechanical HVAC System

The project's mechanical HVAC system is a centralized plant located in the Education Building which serves both the Education Building and Lands Building.

This central plant comprises the following:

- Central water-cooled chiller plant consisting of one 470kWr low load chiller with heat recovery function and three 1,460kWr high load chillers (2x duty & 1x standby). The chilled water is circulated in a primary-secondary pump arrangement, whereby:
    - The primary chilled water loop arrangement includes circulation between the main chilled water return headers and supply headers through the chiller evaporators (4x primary chilled water pumps, 3x duty & 1x standby).
    - The secondary chilled water pumps circulate chilled water to both the Education and Lands Building. Each building has its own duty-standby secondary chilled water pumps (i.e. 1x duty & 1x standby secondary chilled water pumps for each building). The low temperature chilled water is supplied to the air handling units and fan coil units distributed across the Education and Lands Building.
- Heat rejection is via four equal sized roof-mounted cooling towers (3x duty & 1x standby) which are sized to provide 28.5 degree condenser water to the chilled water plant for heat rejection via the condenser water pumps (4x condenser water pumps, 3x duty & 1x standby). In addition, the condenser water supply supplements the water-cooled kitchen refrigeration plants located at Lower Ground and Basement 3 of Education Building and is driven by a separate duty-standby condenser water pump set (1x duty & 1x standby).
- Central heating hot water generators consist of three 1,250kW gas-fired condensing boilers (2x duty & 1x standby). The heating hot water are circulated in a primary-secondary pump arrangement, whereby:
    - The primary heating hot water loop arrangement includes circulation between the main heating hot water return headers and supply headers through the condensing boilers (3x primary heating hot water pumps, 2x duty & 1x standby). The low-load heat recovery chiller contributes heating hot water to the heating hot water loop.
    - The secondary heating hot water pumps circulate heating hot water to both the Education and Lands Building. Each building has its own duty-standby secondary heating hot water pumps (i.e. 1x duty & 1x standby secondary heating hot water pumps for each building). The heating hot water is supplied to the air handling units and fan coil units distributed across the Education and Lands Buildings. In addition, the heating hot water passes through a set of dedicated heat exchangers to provide indirect heating to the pool circulation loop of the Lap Pool and Vitality Pool located at Level 5 of Education Building.
    - Separate secondary heating hot water pumps (1x duty & 1x standby) circulate heating hot water through a dedicated heat exchanger to provide pre-heating to the incoming potable cold water on the hydraulic side for domestic hot water provision.
- The air distribution system for each building are configured as follows:
    - Education Building:
        - Each hotel floor comprises a group of air handling units supplying pre-treated air to the floor. The corridor receives pre-treated air only, while guestrooms and ancillary spaces are served pre-treated air to a local fan coil unit, which handles hotel room loads.
        - The pool facilities located at Level 5 of Education Building has a dedicated air-to-air heat recovery air handling unit to pre-heat incoming outside air with the exhaust air via its internal plate heat exchangers. Other pool facility spaces such as the gym, spas, and treatment rooms are provided with local fan coil units to meet room loads.
        - All other conditioned ancillary spaces within the Education Building are provided with local fan coil unit(s).
    - Lands Building
        - Retail and commercial tenancies from Lower Ground up to Level 1 are provided with local fan coil units with direct outdoor air supply.
        - Dedicated groups of air handling units are provided to large function room spaces at Level 2 and 3 of Lands Building.
        - All conditioned ancillary & corridor spaces within the Lands Building are provided with local fan coil unit(s).

5.7.2 HVAC Central Chiller Plant Modelling

5.7.2.1 Water-cooled Chillers System Operation

A total of four Carrier chillers (i.e. three 1,460kW high load chillers – CH.EB.B1.01 to CH.EB.B1.03, one 470kW low load chiller with heat recovery function – CH.EB.B1.04) forms part of the project's HVAC central chiller plant system. These chillers are designed to have the following characteristics:

- Chilled Water Leaving Temperature: 7°C
- Chilled Water Return Temperature: 12°C
- Condenser Water Leaving Temperature from chillers: 35°C (for cooling mode)
- Condenser Water Entering Temperature from chillers: 28.5°C (for cooling mode)
- Condenser Water Leaving Temperature from low load chillers: 50°C (for heat recovery mode)
- Condenser Water Entering Temperature from low load chillers: 40°C (for heat recovery mode)

Up to two of the three high load chillers are staged to operate at a given time as they are configured as 2x duty and 1x standby while the low load chiller is intended to operate at all times when heating is required.

Stage	Lead	Lag 1	Lag 2	Standby	KWR
1	CH-4			CH-1, CH-2 & CH-3	470
2	CH-1			CH-2 & CH-3	1460 (+470)
2	CH-2			CH-1 & CH-3	1460 (+470)
2	CH-3			CH-1 & CH-2	1460 (+470)
3	CH-1	CH-2		CH-3	2920
3	CH-2	CH-3		CH-1	2920
3	CH-3	CH-1		CH-2	2920
4	CH-4	CH-1	CH-2	CH-3	3390
4	CH-4	CH-2	CH-3	CH-1	3390
4	CH-4	CH-3	CH-1	CH-2	3390

Figure 6 –Chiller Plant Staging

5.7.2.2 Water-cooled Chillers System Performance

The tables below lists the proposed Carrier high load chiller (CH.EB.B1.01 to CH.EB.B1.03) and low load chiller (CH.EB.B1.04) plant part load Coefficient of Performances (COPs) at constant entering condenser water temperatures of 29.5°C, 25°C, 23.9°C and 20°C. The part load COPs were based on the chiller manufacturer's technical data. Refer to Appendix D for further detail.

Table 16 – High Load Chiller (CH.EB.B1.01 to CH.EB.B1.03) Plant Part Load Performance

Stage	Total Chiller Plant Output (kW)	Percent Load (%)	Chiller COP @ 29.5°C	Chiller COP @ 25°C	Chiller COP @ 23.9°C	Chiller COP @ 20°C
1	146	10%	3.758	4.168	4.896	4.495
2	292	20%	5.084	6.745	7.168	9.317
3	438	30%	6.048	7.985	8.470	10.58
4	584	40%	6.584	8.411	8.852	10.71
5	730	50%	6.650	8.566	8.955	10.80
6	876	60%	6.579	8.162	8.626	10.50
7	1,022	70%	6.453	7.991	8.395	10.18
8	1,168	80%	6.301	7.782	8.138	9.702
9	1,314	90%	6.073	7.480	7.849	9.261
10	1,460	100%	5.816	7.128	7.497	8.847

Table 17 – Low Load Chiller (CH.EB.B1.04) Plant Part Load Performance

Stage	Total Chiller Plant Output (kW)	Percent Load (%)	Chiller COP @ 29.5°C	Chiller COP @ 25°C	Chiller COP @ 23.9°C	Chiller COP @ 20°C
1	94	20%	5.310	6.314	6.620	9.529
2	141	30%	6.485	7.715	8.103	10.99
3	188	40%	6.975	8.449	8.871	11.47
4	235	50%	6.752	8.260	8.697	11.23
5	282	60%	6.598	8.136	8.584	11.02
6	329	70%	6.749	8.030	8.353	10.37
7	376	80%	6.544	7.686	7.968	9.853
8	423	90%	6.320	7.356	7.617	9.423
9	470	100%	6.051	7.035	7.295	9.045

5.7.2.3 Cooling Towers (Heat Rejection)

Heat rejection for the central chiller plant is provided by four equal sized roof-mounted cooling towers designed with heat rejection capacity of 1,415.2 kW each. Up to three of the four cooling towers are staged to operate in parallel (each running simultaneously where optimal), configured as 3x duty and 1x standby.

The cooling tower fans are equipped with variable speed drives (VSD) which modulates to maintain the desired common cooling tower leaving water temperature of 28.5°C. This is served to the chilled water plant as well as the water-cooled kitchen refrigeration plants within the Lower Ground and Basement 3 of Education Building.

The total cooling tower fan power input in Table 18 has been modelled based on the individual fan curves and efficiencies, and the model also accounts for motor and VSD losses. A linear part-load performance has been allowed in the model.

Table 38 – Cooling Tower Fans Modelled

Cooling Tower Fans	Capacity (kW)	Flow Rate (l/s)	Fan Input Power (kW)
CT.EB.L9.01	1,415.2	57.6	36.9
CT.EB.L9.02	1,415.2	57.6	36.9
CT.EB.L9.03	1,415.2	57.6	36.9
CT.EB.L9.04	1,415.2	57.6	36.9
Total CT Fans (kW) – 3x Duty & 1x Standby			110.7

5.7.2.4 Chilled Water Pumps and Condenser Water Pumps

The chilled water is circulated in a primary-secondary pump arrangement, whereby:

- The primary chilled water loop arrangement includes circulation between the main chilled water return headers and supply headers through the chiller evaporators (4x primary chilled water pumps, 3x duty & 1x standby).
- The secondary chilled water pumps circulate chilled water to both the Education and Lands Building. Each building has its own duty-standby secondary chilled water pumps (i.e. 1x duty & 1x standby secondary chilled water pumps

for each building). The low temperature chilled water is supplied to the air handling units and fan coil units distributed across the Education and Lands Building.

Condenser water pumps (4x condenser water pumps, 3x duty & 1x standby) drive condenser water from the cooling towers to the chillers at constant speed.

The tables below lists the chilled water (CHW) pump and condenser water (CW) pump powers modelled. All of the associated equipment are configured as Duty/Standby and designed to operate by VSD. Therefore, the chiller pumps operate in line with the staging controls of its respective chillers to meet the development's cooling demand whilst the condenser water pump provide constant condenser water flow to meet the chiller flow demand. Upon pump failure the next available pump is started, if the lead pump fails then pump order is rotated.

The total pump input power of the CHW pumps and CW pumps have been modelled based on the individual pump curves & pump efficiencies, and the model also accounts for motor and VSD losses.

Table 19 – Chilled Water Pumps Modelled

Chilled Water Pumps	System Type	Flow Rate (l/s)	Pressure (kPa)	Pump Absorbed Power (kW)	Pump Input Power (kW)
PCHWP.EB.B1.01	Primary Chilled Water System	69.7	215	21.5	23.89
PCHWP.EB.B1.02	Primary Chilled Water System	69.7	215	21.5	23.89
PCHWP.EB.B1.03	Primary Chilled Water System	69.7	215	21.5	23.89
PCHWP.EB.B1.04	Primary Chilled Water System	69.7	215	21.5	23.89
Total Primary CHW Pumps (kW) – 3x Duty & 1x Standby				64.5	71.67
SCHWP.EB.B1.01 (Duty)	Secondary Chilled Water System - Lands	71.7	315	29.7	33.00
SCHWP.EB.B1.02 (Standby)	Secondary Chilled Water System - Lands	71.7	315	29.7	33.00
SCHWP.EB.B1.03 (Duty)	Secondary Chilled Water System - Education	86.8	275	30.6	34.00
SCHWP.EB.B1.04 (Standby)	Secondary Chilled Water System - Education	86.8	275	30.6	34.00
Total Secondary CHW Pump (kW) – 1x Duty & 1x Standby each building				60.3	67.00
Total CHW Duty Pumps Input Power (kW)				**124.8**	**138.67**

Table 20 – Condenser Water Pumps Modelled

Condenser Water Pumps	System Type	Flow Rate (l/s)	Pressure (kPa)	Pump Absorbed Power (kW)	Pump Input Power (kW)

CWP.EB.B1.01	Condenser Water System	52.0	200	12.9	14.33
CWP.EB.B1.02	Condenser Water System	52.0	200	12.9	14.33
CWP.EB.B1.03	Condenser Water System	52.0	200	12.9	14.33
CWP.EB.B1.04	Condenser Water System	52.0	200	12.9	14.33
Total CWP Pump Input Power (kW) – 3x Duty & 1x Standby				**38.7**	**43.00**
(CW)HHWP.EB.B1.01 (Duty)	Primary Hot Water Heating Recovery System	14.8	225	5.28	5.87
(CW)HHWP.EB.B1.02 (Standby)	Primary Hot Water Heating Recovery System	14.8	225	5.28	5.87
Total CW Duty Pumps Input Power (kW)				**43.98**	**48.87**

5.7.2.5 Combine Operational Mapping Approach

For energy modelling purposes of the central chiller system, a chilled water and condenser water plant operation map was created to reflect the operational staging of the chillers, chilled water pumps, condenser water pumps and cooling tower fans against the building cooling load, as shown in Table 21. The chiller system plant staging is based on the mechanical design intent – refer to Appendix E.

The primary chilled water pumps (PCHWP.EB.B1.01 to PCHWP.EB.B1.04) are modelled such that its variable flow rate cannot reduce below a minimum 50% of the design flow as per the chiller manufacturer advice. The secondary chilled water pumps (SCHWP.EB.B1.01 to SCHWP.EB.B1.04) serving to its respective buildings of the hotel development are modelled to modulate its flow rate without minimum restriction based on the respective building's cooling load demand.

The condenser water pumps (CWP.EB.B1.01 to CWP.EB.B1.04) are modelled such that the flow rate are keep at constant design flow rate as per the chiller manufacturer advice.

Table 21 – Chilled Water Plant staging modelled

Stage	Total Chiller Plant Output (kW)	CH.EB.B1.01 Output (%)	CH.EB.B1.02 Output (%)	CH.EB.B1.04 Output (%)	CHWP Pump Power (%)	CWP Pump Power (%)	CT Fan Power (%)
1	94	0	0	20	12	23	2
2	188	0	0	40	12	23	3
3	282	0	0	60	12	23	5
4	423	0	0	90	12	23	8
5	438	30	0	0	15	29	10

6	730	50	0	0	19	29	17
7	876	60	0	0	23	29	20
8	1,022	70	0	0	27	29	23
9	1,431	98	0	0	38	29	33
10	1,460	50	50	0	38	59	33
11	1,752	60	60	0	46	59	40
12	2,044	70	70	0	54	59	47
13	2,336	80	80	0	61	59	53
14	2,628	90	90	0	69	59	60
15	2,891	99	99	0	76	59	66
16	2,915	86	86	86	77	81	65
17	3,051	90	90	90	81	81	68
18	3,390	100	100	100	88	81	75

5.7.3 HVAC Central Heating Hot Water Plant Modelling

5.7.3.1 Heating Hot Water Generators System Operation & Performance

Three equal sized 1,250kW gas-fired condenser boilers modules are providing heating to the Education Building and Lands Building and were modelled as per the mechanical documentation attached in Appendix D. These heating hot water generators are staged to operate as 2x duty and 1x standby with a minimum thermal efficiencies of 96.0% at 50 / 40 degree operation. Table 22 shows the modelled boiler plant output and efficiency. A constant part-load thermal efficiency of 96% has been input to the model.

Table 22 – Heating Hot Water Plant modelled

Boiler	Boiler Capacity (kW)	Boiler Thermal Efficiency % at 50 / 40c
HWH.EB.B1.01 to HWH.EB.B1.03	1,250 kW x 2 Duty Boilers = 2,500 kW	96.0%

The heating energy savings via the low load chiller's heat recovery function has been accounted for in the model. This heat recovery benefit occurs when the development has a heating demand in which the low load chiller will be in operation and produces 50°C condenser water to the supply header of the primary heating hot water loop. A percentage of heating energy is saved by having an alternate source of heating hot water which will relax the operation of the mechanical heating hot water generators, though is expected to occur for a fraction of the year,

Using the HVAC simulation results, a 15% heat recovery benefit was estimated and applied to the annual heating energy consumption associated with the mechanical heating hot water generators.

5.7.3.2 Heating Hot Water Generator Pumps

Heating hot water is circulated in a primary-secondary pump arrangement, whereby:

- The primary heating hot water loop arrangement includes circulation between the main heating hot water return headers and supply headers through the condensing boilers (3x primary heating hot water pumps, 2x duty & 1x standby).
- The secondary heating hot water pumps circulate heating hot water to both the Education and Lands Building. Each building has its own duty-standby secondary heating hot water pumps (i.e. 1x duty & 1x standby secondary heating hot water pumps for each building). The heating hot water is supplied to the air handling units and fan coil units distributed across the Education and Lands Building.
- Note the (CW)HHWP.EB.B1.01 and (CW)HHWP.EB.B1.02 pumps associated with the low load heat recovery chillers to deliver 50°C condenser water to the supply header of the primary heating hot water loop were accounted for in Section 5.7.2.4,

Table 23 below lists the heating hot water (HHW) pumps modelled. All of the associated equipment are configured as Duty/Standby and designed to operate by VSD. Therefore, pumps operate in line with the staging controls of its respective condensing boiler unit and modulate to meet the heating hot water flow demand. Upon pump failure the next available pump is started, if the lead pump fails then pump order is rotated.

The total pump input power (maximum absorbed electrical power) of the HHW pumps have been modelled based on the individual pump curves & pump efficiencies, and the model also accounts for motor and VSD losses.

Table 23 – Heating Hot Water Pump modelled.

Heating Hot Water Pumps	System Type	Flow Rate (l/s)	Pressure (kPa)	Pump Absorbed Power (kW)	Pump Input Power (kW)
PHHWP.EB.B1.01	Primary Hot Water System	29.9	200	8.3	9.2
PHHWP.EB.B1.02	Primary Hot Water System	29.9	200	8.3	9.2
PHHWP.EB.B1.03	Primary Hot Water System	29.9	200	8.3	9.2
Total Primary HHW Pumps (kW) – 2x Duty & 1x Standby				16.6	18.4
SHHWP.EB.B1.01 (Duty)	Secondary Hot Water System - Education	27.0	300	11.6	12.9
SHHWP.EB.B1.02 (Standby)	Secondary Hot Water System - Education	27.0	300	11.6	12.9
SHHWP.EB.B1.03 (Duty)	Secondary Hot Water System - Lands	18.6	300	8.47	9.4
SHHWP.EB.B1.04 (Standby)	Secondary Hot Water System - Lands	18.6	300	8.47	9.4
Total Secondary HHW Pump (kW) – 1x Duty & 1x Standby each building				20.07	22.3
Total HHW Duty Pumps Input Power (kW)				**36.67**	**40.7**

Domestic hot water is pre-treated by the heating hot water loop. Secondary pumps extend the heating hot water circulation for domestic hot water pre-heating and pool heating via heat exchangers, however these are not included in the HVAC simulation. Instead, refer to Section 5.10.2.3 and 5.16.2for pump energy use associated with domestic hot water pre-heating and pool heating respectively.

5.7.4 HVAC Air Distribution System Modelling

5.7.4.1 HVAC Air Distribution System

The project's mechanical HVAC air distribution system generally comprises of fan-coil units and air handling units served from centralised plant (i.e. water cooled chillers with cooling towers, gas fired condensing boilers, etc.) serving to both Education and Lands Building.

For the Education Building:

- **Guestroom corridor air conditioning (pre-treatment of outside air)**: Each hotel floor (Level 1 to Level 9) comprises a group of air handling units which continuously pre-treats outdoor air to 22°C ± 0.5°C and delivered to the guest corridors.
- **Guestroom air conditioning**: The same group of air handling units providing pre-treated air to the guest corridors at each hotel floor (Level 1 to Level 9) also extends to the guestrooms themselves. Each guestroom has their own local fan coil unit to handle room loads and allow access to guestroom temperature controls by the guests.
- **Level 5 Indoor Swimming Pool:** The indoor swimming pool is served by an air-to-air heat recovery air handling unit located at the pool room skylight area. The heat recovery unit is used to pre-cool or heat 100% of outside air using the system relief air from the pool area in order to achieve a comfort zone temperature of 28°C ± 1.5°C
- **Ancillary Spaces/Rooms**: All ancillary spaces/room requiring air-conditioning are provided with fan coil unit(s) within the space to supply air temperatures at its design temperature conditions.

For the Lands Building:

- **Ancillary Spaces/Rooms**: All ancillary spaces/room requiring air-conditioning are provided with air handling unit(s) and/or fan coil unit(s) within the space to supply air temperatures at its design temperature conditions.
- **Corridor air conditioning**: Corridors of each floor comprises a group of fan coil units which continuously supplies pre-treated outdoor air to maintain indoor thermal comfort conditions.

The supply and outside air flow rates, heating/cooling coil capacities, pressure, and power fan input kW of each air handling units and fan coil units allowed in the model are in accordance with mechanical schedule attached in Appendix D.

5.7.4.2 HVAC Air Distribution System Control Strategy

The simulation model has allowed the following HVAC system control strategy based on the Mechanical BMCS Functional Description Report (see Appendix E) as well as the anticipated control operations as advised by the project's mechanical services consultant and contractor.

Table 24 identifies the operational control strategy and space temperature control range allowed in the assessment.

Table 24 – HVAC Air Distribution System Controls.

Space Type	Operating Control Strategy Applied	Space Temperature Control Range during Air-Con Operation (ºC)
Education Building - Guest Rooms	18 hours (4PM to 10AM), 7 days/week operation, with allowance of fan speed occupant operation controls to the hotel fan coil units at: • High speed (90% supply flowrate) from 4PM to 9PM • Medium speed (60% supply flowrate) from 6AM to 10AM • Low Speed (30% supply flowrate) at all other times between 4PM to 10AM	21 - 24

	Note a 70% diversity factor is applied to the conditioning call in line with anticipated occupancy rates as seen in benchmark hotels from the operator.	
Education Building - Corridors and Lift Lobbies	24 hours, 7 days Operation Served constant volume 100% outside air at tempered condition, no thermostat control is provided.	22
Education Building – Level 5 Pool	15.5 hours (6:30AM to 10PM), 7 days/week operation Heat recovery function by the air handling unit's heat exchanger has been accounted for in the model.	28 +/- 1.5
Education Building – Level 5 Gym	15.5 hours (6:30AM to 10PM), 7 days/week operation	21 - 24
Education Building – Level 5 Spa	15.5 hours (6:30AM to 10PM), 7 days/week operation	21 - 24
Education Building – Level 5 Change Rooms	15.5 hours (6:30AM to 10PM), 7 days/week operation	21 - 24
Education Building – Level 5 Sauna/Steam Room	15.5 hours (6:30AM to 10PM), 7 days/week operation	28 +/- 1.5
Education Building – Kitchen related spaces	16 hours (6:30AM to 10:30PM), 7 days/week operation	21 - 24
Education Building – BOH Office	Assumed NCC 2019 Class 5 (Table 2c)	21 - 24
Education Building – Function Rooms	Operations is in line with occupancy schedules for Conference areas (including function rooms) as per the NABERS Handbook for Estimating NABERS Ratings.	21 - 24
Education Building – Ground Floor Palm Court Seating & Reception	24 hours, 7 days Operation	21 - 24
Education Building – Guest Lounge (e.g. Ground Floor Capella Living Room – Library & Library 2)	24 hours, 7 days Operation	21 - 24
Lands Building – Corridor/Lobby	24 hours, 7 days Operation	21 - 24
Lands Building – Function-related spaces	Operations is in line with occupancy schedules for Conference areas (including function rooms) as per the NABERS Handbook for Estimating NABERS Ratings. Air handling units serving the Lands Building function spaces have VSD controls to modulate the supply air with an average minimum turndown of 40%. CO2 sensors control this turndown based on a CO2 concentration range of 600ppm for minimum outdoor air, and 800ppm for maximum outdoor air.	21 - 24

Lands Building – restaurants, bar, kitchen-related spaces	16 hours (6:30AM to 10:30PM), 7 days/week operation	21 - 24
Lands Building – Level 3 Dome & Tempietto & Strongroom	Operations is in line with occupancy schedules for Conference areas (including function rooms) as per the NABERS Handbook for Estimating NABERS Ratings. Air handling units serving the Lands Building function spaces have VSD controls to modulate the supply air with an average minimum turndown of 40%. CO2 sensors control this turndown based on a CO2 concentration range of 600ppm for minimum outdoor air, and 800ppm for maximum outdoor air.	21 - 24

5.7.5 Communication Room Air-Conditioning Units

The server communications room located in Basement 3 of Education Building are provided with communication room air-conditioning (CRAC) units to provide continuous cooling, one of which (FCU.EB.B3.01) is connected to the central chiller plant whereas the other (FCU.EB.B3.02) is a standalone direct expansion cooling unit. These CRAC units are modelled as per the mechanical equipment schedule (see Appendix D) as follows:

Table 25 – CRAC Unit System Modelling Inputs

Description	FCU.EB.B3.01	FCU.EB.B3.02 / CU.EB.B1.02
Cooling Capacity (kW)	36.1	38.7
Operational Hours	On continuous (24 hours, 7 days)	On continuous (24 hours, 7 days)
Input Power (kW)	-	14.68
Coefficient of Performance	N/A – refer to Section 5.7.2.5	2.79

5.8 Ancillary Ventilation System

5.8.1 Loading Dock Ventilations

There is no carpark for this development. A naturally ventilated loading dock is situated at the Lower Ground floor of the Education Building. An exhaust fan is provided with CO monitored control.

5.8.2 General Ventilation Systems

General ventilation air fans have been included in the model and are based on the Mechanical documentation as summarized in the table below. Only the supply and exhaust ventilation systems that service the rated areas considered for NABERS Hotel Energy ratings are considered.

The predicted energy consumption for the ancillary ventilation fans for the development is estimated to be **676,168** kWh/annum. Refer to Table 26 and Appendix I for details of ventilation fan energy consumption calculations.

Table 26 – Ventilation Fan modelled.

Typical Fan Name	Area Served	Operation Profile	Energy Consumption (kWh/annum)
KEF.EB.XX.XX	Education Building – Kitchen Exhaust	Kitchen Operation – 7 days a week, 16 hours. No fan speed controls.	78,606
KSAF.EB.XX.XX	Education Building – Kitchen Supply	Kitchen Operation – 7 days a week, 16 hours. No fan speed controls.	24,645
TEF.EB.XX.XX	Education Building – Toilet Exhaust	Guestroom Toilet – On continuous - 24 hours, 7 days a week Pool Changeroom Toilet – 16 hours, 7 days a week (Pool Service Operational Hours)	125,965
SAF.EB.XX.XX	Education Building – General Supply	Function Room – Assumed 7 days a week, 16 hours. No fan speed controls. BOH / Services – on continuous, 24 hours, 7 days a week Pool Changeroom Facility – 16 hours, 7 days a week (Pool Service Operational Hours)	108,325
GEF.EB.XX.XX	Education Building – General Exhaust	BOH / Services – on continuous, 24 hours, 7 days a week	45,026
EAF.EB.L5.01	Education Building – L5 Changeroom Exhaust	Pool Changeroom Facility – 16 hours, 7 days a week (Pool Service Operational Hours)	993
LEF.EB.L9.01	Education Building – Loading Dock Exhaust	On continuous, 24 hours, 7 days a week. On average, these exhaust fans are expected to operate at 30% turndown as they are controlled by CO sensors.	7,779
SPF.EB.L9.XX	Education Building – Stair Pressurisation	Only turned on upon Fire MODE. Allowance of 1 hour per month for testing	136
SPRAF.EB.L2.01	Education Building – Stair Pressurisation Relief	Only turned on upon Fire MODE. Allowance of 1 hour per month for testing	19
PRSAF.EB.B2.01	Education Building – Plant Room Supply	On continuous, 24 hours, 7 days a week.	6,044
BFEF.EB.B2.01	Education Building – Plant Room Exhaust	On continuous, 24 hours, 7 days a week.	5,751
TEF.LB.XX.XX	Lands Building – Toilet Exhaust	On continuous - 24 hours, 7 days a week	39,508

OAF.LB.XX.XX	Lands Building – Outdoor Air Fan	Function Room – Assumed 7 days a week, 16 hours. 8.5% energy reduction applied to accommodate for fan speed modulation & CO2 sensor controls	74,885
SAF.LB.XX.XX	Lands Building – General Supply	Function Room – Assumed 7 days a week, 16 hours. 8.5% energy reduction applied to accommodate for fan speed modulation & CO2 sensor controls	748
GEF.LB.XX.XX	Lands Building – General Exhaust	BOH / Services – on continuous, 24 hours, 7 days a week	11,300
RAF.LB.XX.XX	Lands Building – Return Air Fan	Function Room – Assumed 7 days a week, 16 hours. 8.5% energy reduction applied to accommodate for fan speed modulation & CO2 sensor controls	67,597
KSF.LB.XX.XX	Lands Building – Kitchen Supply	Kitchen Operation – 7 days a week, 16 hours. No fan speed controls.	8,760
KEF.LB.XX.XX	Lands Building – Kitchen Exhaust	Kitchen Operation – 7 days a week, 16 hours. No fan speed controls.	70,080
Total Ancillary Ventilation Fan Energy Consumption (kWh/annum)			**676,168**

5.9 Electrical Lighting Services

5.9.1 Internal Lighting

The internal lighting loads shown in Table 26 are based on the maximum lighting power densities under the NCC 2016 Volume 1 Amendment 1 for the Education Building and NCC 2019 Volume 1 Amendment 1 for the Lands Building. Insufficient information was available at the time of assessment to conduct a thorough internal lighting calculation. The maximum allowable lighting power densities from the applicable NCC version for each building is considered to be a conservative estimate of internal lighting energy.

The following tables summarises the lighting power densities with assigned lighting profiles and lighting efficiency measures incorporated into the internal lighting energy calculations. Refer to Appendix J for further details to the internal lighting energy calculations and applied adjustment factors to spaces with lighting efficiency measures.

The estimated internal lighting annual energy consumption is **808,637** kWh/annum.

Table 26 – Internal Lighting modelled.

Space Type	Lighting Power Density (W/m2)	Operational Profile	Lighting Efficiency Measures	Energy Consumption (kWh/year)
Back of House (BOH)	Education Building – 5 W/m2 Lands Building – 3 W/m2	Assumed 24 hours, 7 days per week	Motion detectors (light fitting serving < 100m2)	9,384
Loading Dock	Education Building – 6 W/m2	Assumed 24 hours, 7 days per week	Motion detectors (light fitting serving +100m2)	10,010

Cleaner's Room	Education Building – 5 W/m2 Lands Building – 1.5 W/m2	Assume operation from 7AM to 11PM per BMS	Motion detectors (light fitting serving < 100m2)	7,264
Conference / Function Room	Education Building – 10 W/m2 Lands Building – 5 W/m2	NABERS Hotel conference / function lighting profile	None	30,129
Control Room, intermittent	Education Building – 9 W/m2 Lands Building – 3 W/m2	Assumed 24 hours, 7 days per week	Motion detectors (light fitting serving < 100m2)	3,883
Corridors / Lobby	Education Building – 8 W/m2 Lands Building – 5 W/m2	Assumed 24 hours, 7 days per week	Timeclock	237,349
Entry Lobby	Education Building – 15 W/m2 Lands Building – 9 W/m2	Assumed 24 hours, 7 days per week	Timeclock	57,824
Kitchen / Food prep	Education Building – 8 W/m2 Lands Building – 4 W/m2	NCC Class 6 restaurant/café lighting profile	None	11,032
Guest Lounge	Education Building – 10 W/m2	Assume operation from 7AM to 11PM per BMS	Motion detectors (light fitting serving < 100m2)	12,432
BOH Office	Education Building – 9 W/m2 Lands Building – 4.5 W/m2	Green Star Table 27 Office Lighting Profile	None	17,023
Pool Hall / Spa / Gym	Education Building – 10 W/m2	Assume operation from 7AM to 11PM per BMS	None	40,496
Restaurant	Education Building – 18 W/m2 Lands Building – 14 W/m2	NCC Class 6 restaurant/café lighting profile	None	109,416
Services Room / Storage	Education Building – 5 W/m2 Lands Building – 1.5 W/m2	Assumed 24 hours, 7 days per week For plant services room, Green Star Table 37 Lighting profile	Motion detectors (light fitting serving < 100m2 or +100m2)	41,977
Guestroom	Education Building – 5 W/m2	NABERS Hotel Room Lighting Profile	None	178,534
Stairs	Education Building – 5 W/m2 Lands Building – 2 W/m2	Assumed 24 hours, 7 days per week	Two stage sensor (motion sensor)	22,694

Toilet Amenities	Education Building – 6 W/m2 Lands Building – 3 W/m2	Assumed 24 hours, 7 days per week	Motion detectors (light fitting serving < 100m2 or +100m2)	22,131
Total Internal Lighting Energy Consumption (kWh/year)				**808,814**

5.9.2 External Lighting

Exterior lighting has been modelled based on the lighting fixtures design across the external facades of Education Building and Lands Building as illustrated on the Electrical Lighting Layout documentations for the respective buildings. All luminaires are modelled to run for an assumed 12.0 hours per day every night from dusk to dawn (6PM to 6AM) with no allowance for dimming controls.

The estimated external lighting annual energy consumption is **25,726** kWh/annum.

Table 27 – External Lighting modelled

External Lighting	Input
Total External Lighting Load (W) – Education Building	17,229
Total External Lighting Load (W) – Lands Building	8,497
Total running hours per year (based on 12 hours per day)	4,380
Total External Lighting Annual Energy Consumption (kWh/year)	**25,726**

5.10 Hydraulic Services

5.10.1 Domestic Hot Water

Domestic hot water for the development is provided through a 2-step heating process, whereby:

- **Step 1 – Pre-heating by Mechanical Services**: Incoming cold potable water at 17.7°C on the hydraulic services side interacts with the heating hot water loop on the mechanical services side via a heat exchanger. The incoming cold water passes through the heat exchangers and becomes pre-heated to 35°C.
- **Step 2 – Additional heating by Hydraulic Services**: Warm potable water exiting the heat exchanger on the hydraulic services side at 35°C then passes through another set of cross-flow heat exchangers with outgoing 65°C hot water. The warm potable water at elevated temperatures is stored in the primary hot water storage tanks (four 1,000L Rheem RT1000) designed to maintain hot water temperatures at 65°C by circulating heated hot water with the gas-fired hot water heaters (two RAYPAK B2634ID with thermal efficiencies of 82%)

Centralized domestic hot water system is situated in the Education Building, domestic hot water is provided to both the Education Building and the Lands Building. The domestic hot water end-uses sources are identified to be:

- Education Building Hotel Guestrooms – Taps & Showers
- Education Building Level 5 Indoor Swimming Pool / Spa / Gym Amenities – Taps & Showers
- Education Building BOH Amenities (e.g. housekeeping, public/staff amenities) – Taps & Showers
- Lands Building BOH Amenities (e.g. public amenities) – Taps & Showers
- Education Building Meal Preparation

Table 28 – Domestic Hot Water System Usage

Hot Water End Uses	Assumptions	Domestci Hot Water Usage (kL/year)
Education Building – Hotel Guestrooms	Based on 75 litres per day per hotel guest rooms as per Section 6.5.9 of NABERS Handbook for Estimating NABERS Energy. A 70% diversity factor has been applied as it is not all guestrooms of the hotel development will be fully occupied. Refer to Section 5.6 of this report.	3,679.2
Education Building – Indoor Pool Amenities	Tap Usage: • 17 taps identified • 0.26 tap uses/hour and 20 seconds per tap use per Section 6.4.6 of NABERS Handbook for Estimating NABERS Energy for basin tap hot water use • Proposed tap flowrate of 4.5 litre per minute Shower Usage • 11 showerheads identified • Assumed 5 minutes per shower use • Proposed tap flowrate of 9.0 litre per minute A 20% diversity has been applied as it is expected that not all guestrooms of the hotel development will be using the indoor swimming pool facilities. Note the indoor swimming pool is accessible only for the guests.	638.2
Education Building – BOH Amenities	Tap Usage: • 34 taps identified • 0.26 tap uses/hour and 20 seconds per tap use per Section 6.4.6 of NABERS Handbook for Estimating NABERS Energy for basin tap hot water use • Proposed tap flowrate of 5.0 litre per minute Shower Usage • 7 showerheads identified • Assumed 5 minutes per shower use • Proposed tap flowrate of 9.0 litre per minute	205.2
Lands Building – BOH Amenities	Tap Usage: • 53 taps identified • 0.26 tap uses/hour and 20 seconds per tap use per Section 6.4.6 of NABERS Handbook for Estimating NABERS Energy for basin tap hot water use • Proposed tap flowrate of 4.5 litre per minute Shower Usage • 1 showerheads identified • Assumed 5 minutes per shower use • Proposed tap flowrate of 9.0 litre per minute	375.3
Education Building – Meal Preparation	Based on 9 litres per meal as per Section 6.5.9 of NABERS Handbook for Estimating NABERS Energy. Refer to Section 5.15 of this report for number of meal counts used to determine its associated domestic hot water usage.	1,350
Total Domestic Hot Water Usage (kL/year)		**6,247.9**

The *Green Star Energy Consumption and Greenhouse Gas Emissions Calculation Guide* is followed closely to calculate the domestic hot water energy consumption. The energy consumption associated with domestic hot water heating via the mechanical services (pre-heating) and hydraulic services (primary heating) have been calculated separately to capture the

different heating hot water generator thermal efficiencies across the domestic hot water heating process. A loss/storage factor of 10% has been applied to the gas storage hot water system on the hydraulic side.

Per Table 29, the resulting energy consumption across the domestic hot water heating process is **1,598,747 MJ/year.**

Table 29 – Domestic Hot Water System Inputs and Energy Consumption

Parameters	DHW Preheating	Primary DHW heating
Domestic Hot Water Demand (kL)	6,247.9	
System Heat Source	Natural Gas	
Hot Water Heater Thermal Efficiency	96% (based on mechanical services heating hot water generators)	82%
Make-up Water Temperature (°C)	17.7	35
Supply Temperature (°C)	35	65
System Standing Loss Factor	N/A – Preheating by mechanical heating hot water generators via heat exchangers	4.28
System Distribution Loss Factor		0.03
Storage Tank Turnover Ratio		0.15
DHW Energy (MJ/year)	**467,789**	**1,130,949**
Total DHW Energy (MJ/year)	**1,598,747**	

5.10.2 Hydraulic Pumps

The table below presents the energy consumption of all hydraulic pumps considered in this model and the appropriate operational profile which can be found in Appendix C.

The total annual hydraulic pump energy consumption is estimated to be **117,535.7 kWh/year**.

Table 30 – Hydraulic Pumps Modelled

Hydraulic Pump Item	Duty Pump Power Input (kW)	Full Load (hours/year)	Energy Consumption (kWh/year)
DHW Recirculation – Education Building (Hotel Floors)	0.76	8,760	6,658
DHW Recirculation – Education Building (Basement Floors)	0.76	5,840	4,438
DHW Recirculation – Lands Building	0.76	7,300	5,548
Cold Water Triplex Pumpset	10	6,916	69,160
DHW Preheat Mechanical Pumps	3.65	3,458	12,621.7
Sewer Pump	4.9	3,900	19,110
Total Hydraulic Pump Energy Consumption (kWh/year)			**117,535.7**

The following hydraulic pumps were identified to be those of most frequent use during operation and have been highlighted for further discussion:

- Domestic Hot Water Recirculation Pumps
- Cold Water Triplex Pressure Pump Set
- Domestic Hot Water Preheat Mechanical Pumps
- Sewer Pumps

5.10.2.1 Hot Water Recirculation Pump

The hot water recirculation pump set consists of three dual pumpset that operate in duty/standby operation, each of which serves to the:

- Education Building Hotel Floors (Lower Ground up to Level 9)
- Education Building Basement Floors (Basement 3 up to Basement 1)
- Whole of Lands Building

It is expected that one of the pumps of the dual pumpset will be in operation at a given time with the other as back-up in the event of pump failure. With each pump having a maximum power input of **0.76kW**, only the duty pump power is considered in the hydraulic pump energy use.

It is anticipated that the DHW recirculation pumps for various parts of the hotel development will differ by demand. As such, it is assumed that:

- DHW recirculation for the Education Building Hotel Floors (Lower Ground up to Level 9) Is continuous at all times to allow hot water to be available for the guestrooms at any time of use.
- DHW recirculation for the Education Building Basement Floors (Basement 3 up to Basement 1) is assumed to be predominantly used by the Production Kitchen in Basement 3 floor. An assumed operation hours of 16 hours per day, 7 days a week is used.
- DHW recirculation for the whole of Lands Building is assumed to be predominantly used by function rooms with access to domestic hot water usage. An assumed operation hours of 20 hours per day, 7 days a week is used.

5.10.2.2 Cold Water Triplex Pumpset

A central triplex pumpset is used to supply potable cold water to both the Education Building and Lands Building and comes with three equally sized 10kW pumps. It has been advised by the hydraulic consultant that this triplex pumpset will operate at 2x duty and 1x standby configuration and the duty pumps are not expected to run at full load. As such, it is assumed that both duty pumps in operation will run at 50% load to deliver sufficient cold water supply on demand. Therefore a total of **10kW** duty input power is used along with a predicted potable water pump operational schedule. Refer to Appendix C for more information of the predicted potable water pump operational schedule used.

5.10.2.3 Domestic Hot Water Preheat Pumps

The DHW pumps associated with pre-heating of the domestic hot water as mentioned in Section 5.10.1 were considered in the hydraulic pumps calculation. As per the mechanical equipment schedule, these dual pumps are configured as duty/standby with a pump power input of **3.65kW**. It is expected these pumps will operate on demand when domestic hot water is called for. Assuming that half of the cold water drawn from the mains is dedicated for hot water heating and usage, only half of the hours per the predicted potable water pump operational schedules is used instead.

5.10.2.4 Sewer Pumps

Sewer pumps were considered as it was advised by the hydraulic consultant that these will be in frequent use and should be accounted for in the energy consumption calculation. Dual pumps with **4.9kW** input power each are arranged in duty/standby. As such, only the duty pump is considered and paired with a predicted sewer pump operational schedule. Refer to Appendix C for more information of the predicted sewer pump operational schedule used.

5.11 Vertical Transportation

The Sandstone Precinct development's vertical transportation system comprises of a total 12 lifts predominantly serving all floors of its respective buildings. The energy use for lifts were calculated using the vertical transportation schedule per the *Green Star Energy Consumption and Greenhouse Gas Emissions Calculation Guide*. Anticipated usage has been provided as appropriate to estimate the number of trips.

It is noted that these lifts feature regenerative drives which improves its energy efficiency via energy re-use In addition, operational controls in place which allows lifts to enter standby mode when not in use or not called for. As such, the total lift energy consumption for the development has been estimated to be **73,039 kWh/year.**

Education Building

There are 6x *Schindler 5500 MRL* lifts serving the Education Building, including 2x Back of House Lifts and 4x Front of House Lifts. All lifts serves all floors of the Education Building including basements with the exception of front-of-house lifts which predominantly serves floors to the hotel accommodation. The following lift product information were referred to its associated specification datasheet.

Table 31 – Lifts Modelling Inputs (Education Building)

Lift Number	BOH Lifts Lift #1 and Lift #2	FOH Lifts Lift #3 and Lift #4	FOH Lifts Lift #5 and Lift #6
Number of Lifts	2	2	2
Annual Trips (per lift)	52,000	219,000	219,000
Distance Travelled (m)	53.86	42.66	37.94
Rated Speed (m/s)	1.6	1.6	1.6
Average Trip time (s)	16.8	13.3	11.9
Lift Rated Capacity (kg)	1,600	1,275	1,275
Average Power Load (kW)	17.02	14.25	14.12
Regenerative Breaks	Yes	Yes	Yes
Standby power (kW)*	0.15	0.15	0.15
Power Off Feature	Yes	Yes	Yes
Standby Hours	18	18	18
Standby Days	260	365	365
Energy Consumption (kWh/year)	**6,430**	**38,477**	**24,942**

* A lift standby power of 0.15 kW is assumed which is based a reference case lift standby power per the Green Star Energy Consumption and Greenhouse Gas Emissions Calculation Guide.

Lands Building

There are 6x lifts serving the Lands Building, including 3x Back of House Lifts and 3x Front of House Lifts. All lifts serves all floors of the Lands Building with the exception of Lift #6 which only serves to Lower Ground and its Mezzanine floor. The lift information presented below were based on the *Lands Building – Vertical Transportation Specification* (Rev. P3) prepared by WSP.

Table 32 – Lifts Modelling Inputs (Lands Building)

Lift Number	West FOH Lifts Lift #1 and Lift #2	East FOH Lift Lift #3	BOH Lifts Lift #4 and Lift #5	DDA Lift Lift #6
Number of Lifts	2	1	2	1
Annual Trips (per lift)	219,000	219,000	52,000	52,000
Distance Travelled (m)	24.315	24.75	31.82	3
Rated Speed (m/s)	1.6	1.6	1.6	0.25
Average Trip time (s)	7.6	7.7	9.9	6.0
Lift Rated Capacity (kg)	1,600	1,600	2,000	400
Average Power Load (kW)	15.00	15.00	15.00	15.00
Regenerative Breaks	Yes	Yes	Yes	Yes
Standby power (kW)*	0.15	0.15	0.15	0.15
Power Off Feature	Yes	Yes	Yes	Yes
Standby Hours	18	18	18	18
Standby Days	365	365	260	260
Energy Consumption (kWh/year)	**13,065**	**6,632**	**4,851**	**1,742**

* A lift standby power of 0.15 kW is assumed which is based a reference case lift standby power per the Green Star Energy Consumption and Greenhouse Gas Emissions Calculation Guide.

5.12 Miscellaneous Loads

An allowance of **1.5 kWh/m2 GFA** has been included in the assessment for all the miscellaneous energy sources such as:

- Fire Systems monitoring
- Distribution board losses
- Automatic Entry Doors
- Small load for cleaning
- Misc. energy sources

5.13 Hotel Guest Room Equipment

The hotel room equipment load associated with the Education Building are estimated using the NABERS Protocol which accounts for the in-room equipment load as well as an allowance for guest IT equipment. Using the NABERS Hotel Room Equipment Operational Hour Profile, the total energy consumption associated with hotel room equipment is estimated to be **258,838.9** kWh/year.

Note a 70% diversity factor has been applied to the general loads and TVs as these devices will not be in use for unoccupied guest rooms. No diversity factors were applied for the remaining guest room load items as it is assumed these devices are running continuously irrespective of guestroom occupancy.

Table 33 – Hotel Guest Room Equipment Modelling Inputs

Guest Room Load Items	Loads
General Loads	160 W/room
IT Equipment (excluding fridges)	50 W/room
TV	150 W/room
Bar Fridges	70 W/room, continuous
Energy Consumption (kWh/year)	**258,838.9**

5.14 Common Area Equipment

Insufficient information was available at the time of assessment to conduct a thorough equipment energy consumption calculation associated with:

- Common areas (lobby, foyer, corridors);
- Dining Areas (restaurant and cafes);
- Back of house areas; and
- Conference areas (including function rooms); and
- Safety, Security and Emergency Systems

An allowance of **11 kWh/m2 GFA** has been included in the assessment.

5.15 Kitchen Equipment

Operational building information for similar sites operated under the same hotel chain were provided by the client to understand the food coverage for guests associated with 6-star luxury premium hotels circa 192 guest rooms. While the provided information was limited, the amount of food coverage provided to guests appears to be dependent on the hotel's meal offerings (i.e. number of meals served to guests per day offered by the hotel) as shown below:

Table 34 – Food coverages for similar luxury star hotels

Reference Hotels	Annual Average Food Coverage	Equivalent Number of Meal per unit per day
Reference #1 – Capella Sanya	145,608	Approx. 2 meals per unit per day
Reference #2 – Capella Singapore	76,776	Approx. 1 meals per unit per day

For the purpose of determining the kitchen equipment energy usage for the Sandstone Precinct development with respect to the predicted NABERS Energy for Hotel rating, a rounding of the highest annual average food coverage data was taken being 150,000 meals per year (equivalent to approx. 2 meals per unit per day). As such, the NABERS default kitchen energy consumption figures per Table 35 were used to estimate the kitchen equipment energy use.

Table 35 – Kitchen Equipment Energy Consumption Modelling Inputs

Parameters	Input
Annual Food Coverage	150,000 meals per year
Kitchen Electricity Use per meal	2.4 kWh per meal (NABERS default)
Kitchen Gas Use per meal	1.9 kWh per meal (NABERS default)

Table 36 – Kitchen Equipment Energy Consumption Estimates

Energy Source	NABERS Default Meals Energy Consumption (kWh/meal)	Total Energy Consumption
Electricity	2.4	**360,000 kWh/year**
Gas	1.9	**1,026,000 MJ/year**

5.16 Swimming Pool

5.16.1 Swimming Pool Heating

On Level 5 of the Education Building features an indoor aquatic facility which includes a Lap Pool (swimming pool) and Vitality Pool (spas) which are heated by the mechanical heating hot water generators via heat exchangers. The energy consumption for pool heating was estimated using the swimming pool heating calculation methodology per the *Green Star Energy Consumption and Greenhouse Gas Emissions Calculation Guide*.

The total swimming pool heating energy consumption for the development has been estimated to be **910,356 MJ/year.**

Table 37 – Swimming Pool Heating Modelling Inputs

	Lap Pool (Swimming Pool)	Vitality Pool (Spas)
Pool Type	Indoor	
Pool Water Volume (m3)	120	12.75
Pool Surface Area (m2)	100	15
Heat Source	Gas fired condensing boiler (central mechanical plant)	
Heating Efficiency	97%	
Design Water Temperature (deg C)	27	38
Energy Consumption (MJ/year)	**592,729**	**317,627**

5.16.2 Swimming Pool Pumps

The swimming pool pump calculations were provided by the pool contractor (Crystal Pool) which details the intended pump operations. The major energy consuming swimming pool pumps for this project includes:

Table 38 – Swimming Pool Pumps Modelling Inputs

Swimming Pool Pump Item	Combined Pump Power Input (kW)	Intended Operations
Filter Pumps	10.99	Filter pumps are expected to operate at all times (i.e. 24 hours, 7 days a week) to maintain hygiene. These pumps are expected to operate at 90% load during pool facility operational hours (i.e. 15.5 hours) and 50% load at all other times
Heat Boost Pumps	1.88	Heat Boost Pumps are expected to operate at all times (i.e. 24 hours, 7 days a week)
UV Dosing	2.2	UV Dosing operation are expected to operate at all times (i.e. 24 hours, 7 days a week)
Spa Features – Spa Jet Pumps, Blowers, Air Beds and Water Features	12.44	Spa features are expected to operate 10% of the time year-round (i.e. 2.4 hours per day)

As such, the total swimming pool pump energy consumption for the development has been estimated to be **119,644.8 kWh/year.**

Table 39 – Swimming Pool Pumps Energy Consumption

Swimming Pool Pump Item	Energy Consumption (kWh/year)
Filter Pumps	89,475.4
UV Dosing	19,272
Spa Features – Spa Jet Pumps, Blowers, Air Beds and Water Features	10,897.4
Total Energy Consumption (kWh/year)	**119,644.8**

6. NABERS Energy Results

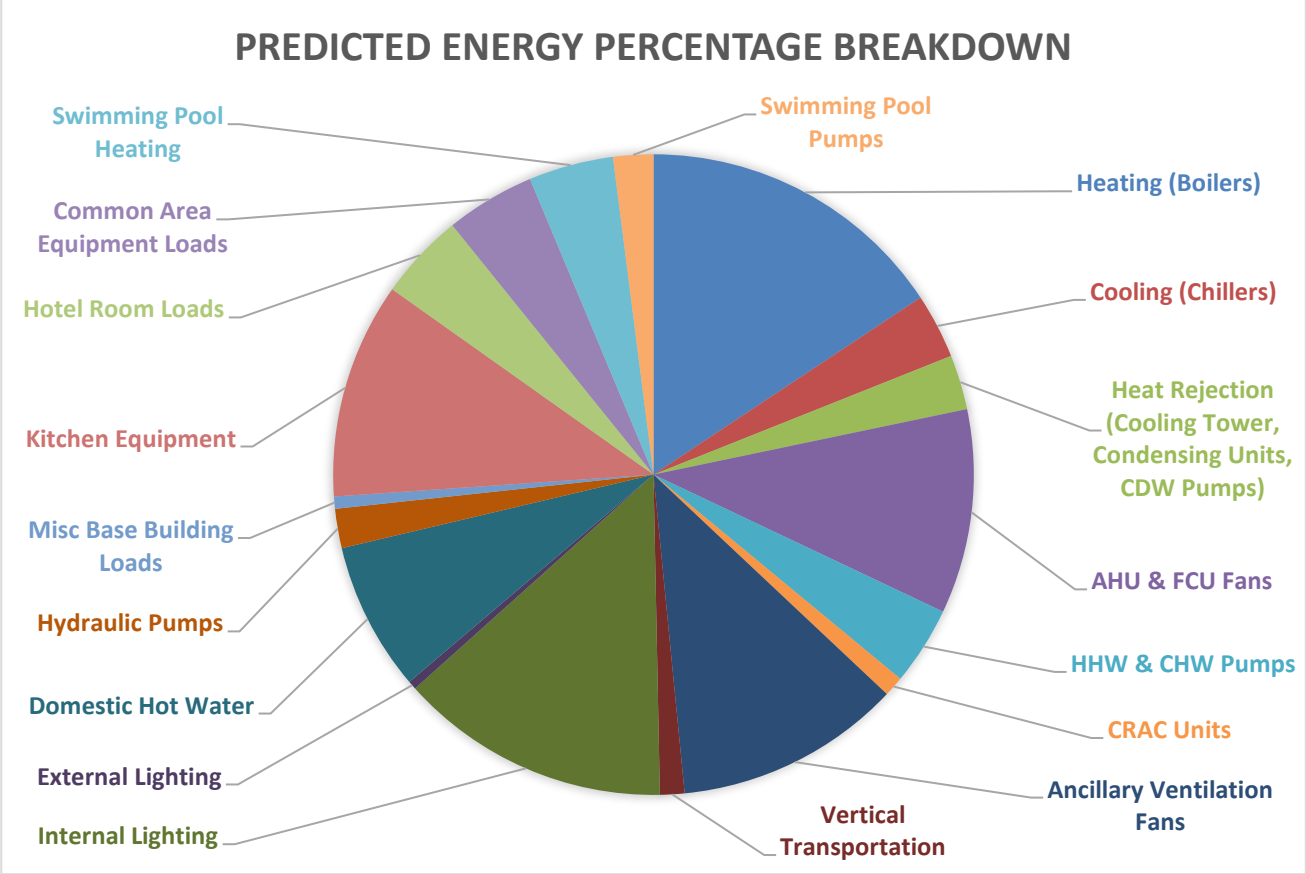
6.1 Modelled Assessment (Reference Case Scenario)

The modelled assessment represents the modeled anticipated energy consumption for the Sandstone Precinct hotel development. The following table lists the amount of energy used for each component of the building in kW/m^2 GFA.

Description	Electricity (kWh/annum)	Gas (MJ/annum)	Energy Use Intensity (kWh/m2 GFA)	Energy Percentage Breakdown
Heating (Boilers)	-	3,338,809	38.31	15.7%
Cooling (Chillers)	193,799	-	8.00	3.3%
Heat Rejection (Cooling Tower, Condensing Unit, and CDW Pumps)	163,079	-	6.74	2.8%
AHU & FCU Fans	610,015	-	25.19	10.3%
HHW & CHW Pumps	234,441	-	9.68	4.0%
CRAC Units	59,687	-	2.47	1.0%
Ancillary Ventilation Fans	676,168	-	27.93	11.4%
Vertical Transportation	73,039	-	3.02	1.2%
Artificial Lighting - Internal	808,814	-	33.41	13.7%
Artificial Lighting - External	25,726	-	1.06	0.4%
Domestic Hot Water	-	1,598,747	18.34	7.5%
Hydraulic Pumps	117,536	-	4.85	2.0%
Misc. Loads	36,318	-	1.50	0.6%
Kitchen Equipment	360,000	1,026,000	26.64	10.9%
Guest Room Equipment	258,839	-	10.69	4.4%
Common Area Equipment Loads	266,333	-	11.00	4.5%
Swimming Pool Heating	-	910,356	10.44	4.3%
Swimming Pool Pumps	119,645	-	4.94	2.0%
Total Energy Use	**4,003,438**	**6,873,912**	**244.21**	**100.0%**
Total GHG Emissions	**4,047,356 kgCO2-e/year**			
NABERS Score	**2 Star NABERS + 59.6%% Improvement**			

The predicted total annual electricity use is 4,003,438 kWh and the total annual gas use is 6,873,912 MJ. This represents a predicted performance in excess of a 2 Star NABERS Hotel Energy Rating level with a +59.6% improvement (relative to 2.5 Star NABERS Hotel Energy Rating).

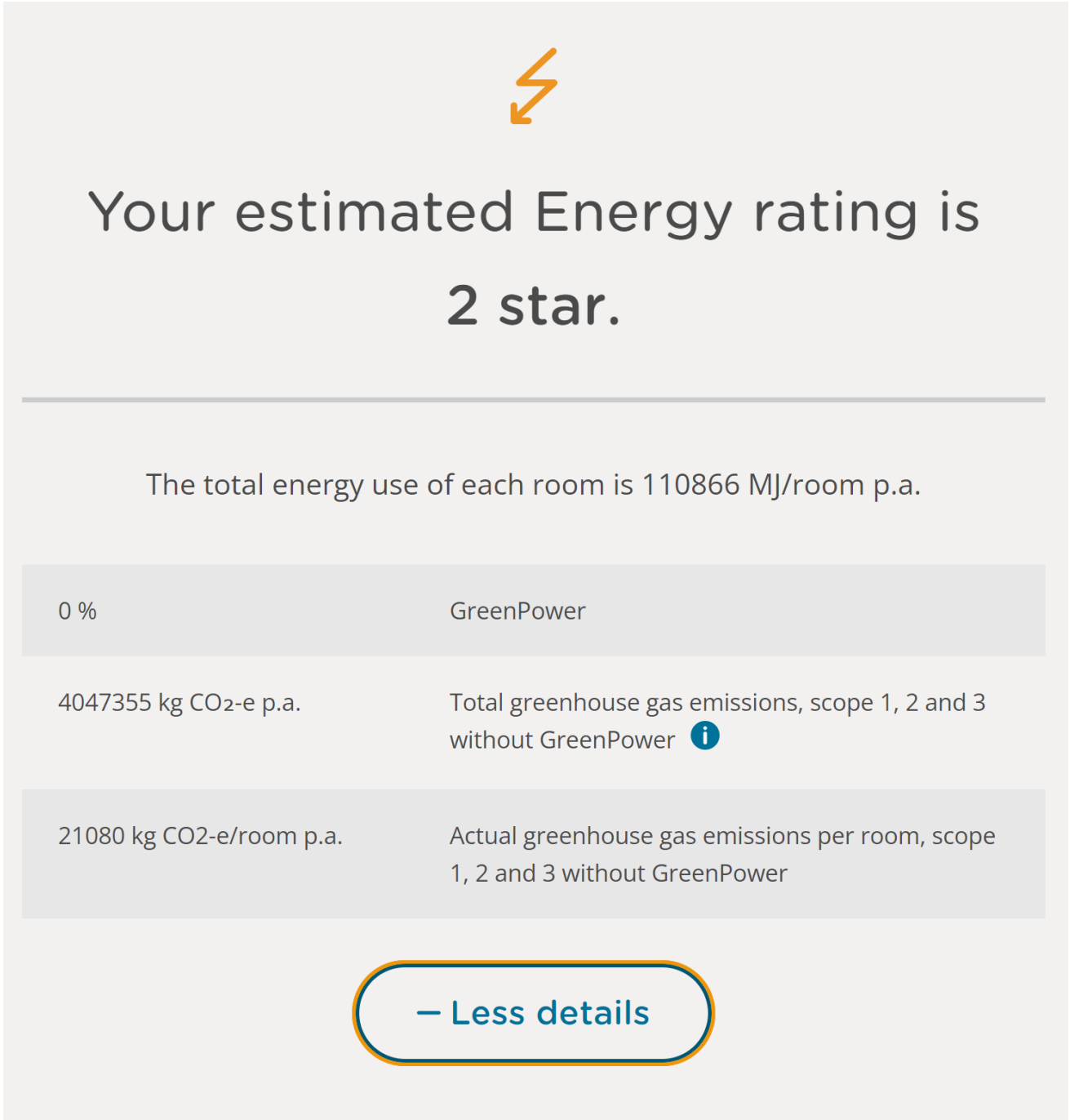
The pie chart below illustrates which energy use component produces the most CO_2 emissions.



6.2 NABERS Rating Results (Reference Case Scenario)

The following is a screenshot of detail input data and the corresponding results obtained from the online NABERS calculator on 03 February 2022.

The results indicate a predicted performance in excess of a 2 Star NABERS Hotel Energy Rating level and is predicted to achieve a 2.3 Star NABERS Hotel Energy Rating.



6.3 Modelled Assessment (Off-Axis Scenario)

A combined off-axis scenario has been developed to consider the operation of the building when operating at conditions different to the design. The compounded cases include:

- **100% occupancy level:** Modelling calculations where a 70% occupancy diversity has been applied is instead, removed. A 100% occupancy rate for a hotel leads to higher energy intensity for the development.
- **Climate Change**: A separate simulation using the Year 2030 predicted weather file (representing a 'worst/warm' case emissions scenario) to observe the climate change impacts to the development. This will affect the HVAC operational energy consumption as the development's heating/cooling demand varies. Refer to Section 4.2 for further details of future weather climate file used.
- **Increased food coverage**: Annual food coverage of 200,000 meals per year is used instead of 150,000 meals per Section 5.15. This figure is based on the highest range of annual food coverage per the operational building information provided for similar hotel sites. Higher food coverage translates to higher kitchen equipment energy consumption and domestic hot water involved with meal preparation.
- **No CO2 sensor controls**: The implementation of CO2 sensors to the Lands Building Function spaces has not been finalized. Should there be no CO2 sensors carried through D&C, an uplift in fan and conditioning and conditioning energy associated to constant volume outside air supply is expected.

The energy calculated for the combined off-axis scenario is shown below with items highlighted in yellow indicating the energy consumption changes with respect to the off-axis factors conditions occur simultaneously.

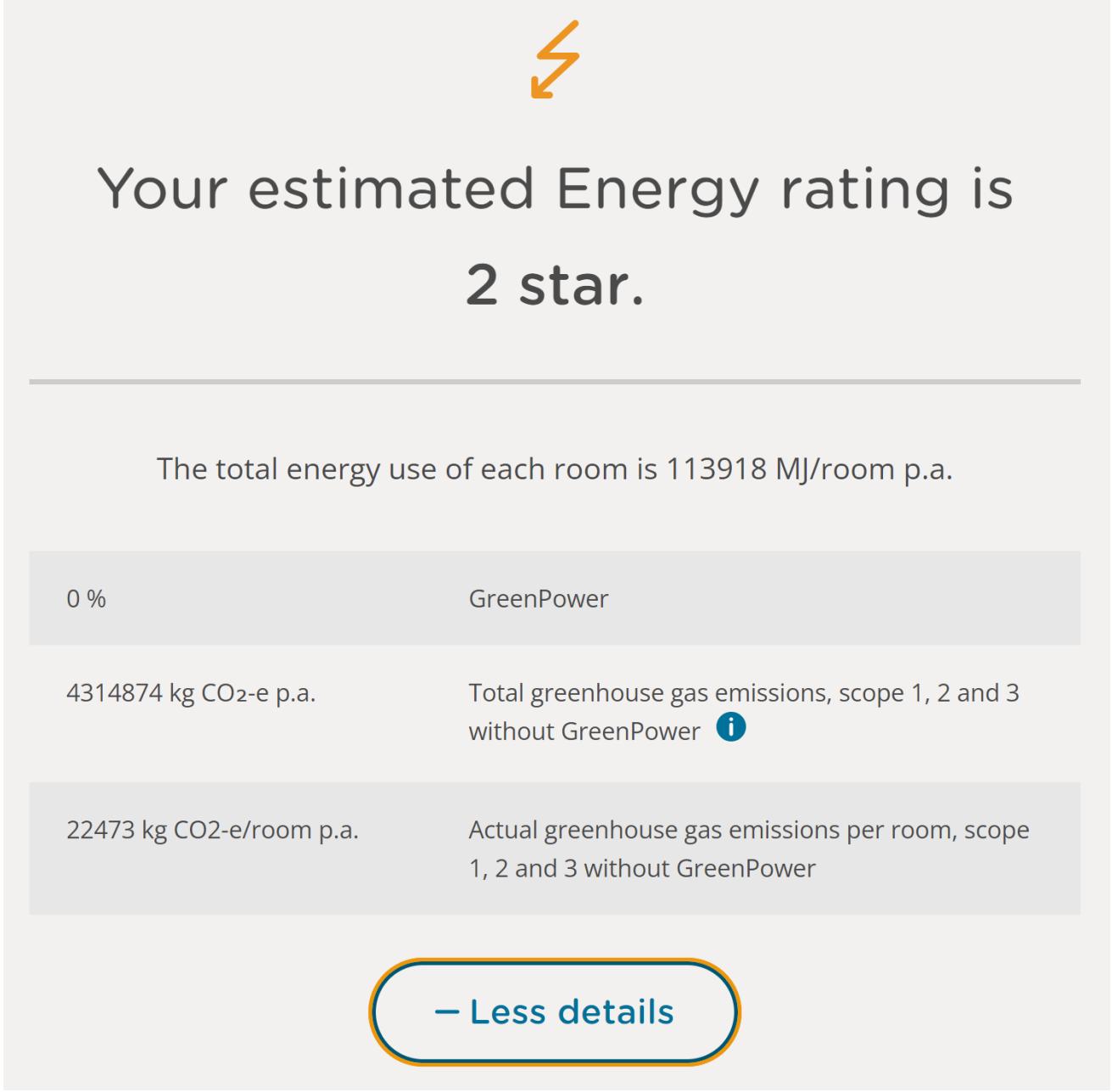
.Description	Electricity (kWh/annum)	Gas (MJ/annum)	Energy Use Intensity (kWh/m2 GFA)	Energy Percentage Breakdown
Heating (Boilers)	-	2,228,763	25.57	10.2%
Cooling (Chillers)	279,695	-	11.55	4.6%
Heat Rejection (Cooling Tower, Condensing Unit, and CDW Pumps)	185,727	-	7.67	3.1%
AHU & FCU Fans	647,018	-	26.72	10.6%
HHW & CHW Pumps	232,801	-	9.62	3.8%
CRAC Units	77,455	-	3.20	1.3%
Ancillary Ventilation Fans	689,473	-	28.48	11.3%
Vertical Transportation	73,039	-	3.02	1.2%
Artificial Lighting - Internal	808,814	-	33.41	13.3%
Artificial Lighting - External	25,726	-	1.06	0.4%
Domestic Hot Water	-	1,713,896	19.66	7.8%
Hydraulic Pumps	117,536	-	4.85	1.9%
Misc. Loads	36,318	-	1.50	0.6%
Kitchen Equipment	480,000	1,368,000	35.52	14.2%

Guest Room Equipment	307,988	-	12.72	5.1%
Common Area Equipment Loads	266,333	-	11.00	4.4%
Swimming Pool Heating	-	910,356	10.44	4.2%
Swimming Pool Pumps	119,645	-	4.94	2.0%
Total Energy Use	**4,347,567**	**6,221,015**	**250.93**	**100.0%**
Total GHG Emissions	**4,314,875 kgCO2-e/year**			
NABERS Score	**2 Star NABERS + 2.6%% Improvement**			

6.4 NABERS Rating Results (Off-Axis Scenario)

The following is a screenshot of detail input data and the corresponding results obtained from the online NABERS calculator on 03 February 2022.

The results indicate a predicted performance in excess of a 2 Star NABERS Hotel Energy Rating and is predicted to achieve a 2.01 Star NABERS Hotel Energy Rating.



7. Energy Metering and Data Collection

7.1 Energy Metering

In accordance with Section 8 of the NABERS Energy and Water for hotels – 'Rules for collecting and using data' (Version 3.2, August 2015), sub-metering is required and must cover all of the energy end uses, including as a minimum the services listed in *Section 8.1.1 Required minimum energy coverage*. These include:

- Common area, guest room and back of house HVAC
- Common area, guest room, exterior and bac of house lighting
- Vertical transportation servicing the hotel
- Car park lighting and ventilation, where provided for the exclusive use of hotel guests or hotel staff
- On site hotel kitchens and restaurant servicing guests with charge-to-room facilities
- Any on-site laundries
- Any on-site heated indoor/outdoor pools for guest use
- Small light and power for both front and back of house
- Lighting, power and HVAC services to any function rooms on site
- Gyms for guest use or gyms with guest charge-to-room facilities, located within the hotel
- Day spas with guest charge-to-room facilities, located within the hotel

As a minimum, all meters must provide the date of reading, meter identification number and meter reading. In addition, the energy meters must have a meter multiplier and calculated energy reading.

7.1.1 Exclusion methodology

The Sandstones precinct combined services operate as a chilled water and heating hot water network. A condenser water loop is not provided to tenants, tenancies are able to access directly the CHW and HHW loop. In order to estimate the amount of energy attributed to the tenancies, a proportional exclusion method has been developed which attributes input electrical and gas energy to the thermal output energy within the CHW and HHW loops:

- Central plant including chillers, heating hot water generators, heat rejection equipment and associated pumps and fans are metered for total consumed electrical energy and gas energy
- The CHW loop and HHW loop are metered at supply and return of the central headers to determine whole building CHW energy and HHW energy consumption.
- Thermal submeters are located at the supply and return of the CHW and HHW branches of each tenancy. These record thermal energy consumed by the tenancy
- The aggregate CHW and HHW consumption of all tenancies as a fraction of the total CHW and HHW produced by the central plant is determined. This fraction is applied to the total input electrical and gas energy of the central plant, which can be excluded from the base building energy demand.
- Electrical meters are installed at each tenancy distribution board to exclude tenant lighting and general power.
- No condenser water loop is provided to Sandstones precinct tenancies.

7.1.2 Metering locations

For the Sandstone Precinct development, the development will have meters on all the following items

Local Authority Metering

- Incoming Supply to Main Distribution Board 1 and Main Distribution Board 2 for Education Building
- Incoming Supply to Main Distribution Board 3 for Lands Building
- Gas Mains to the Sandstone Precinct Development (excluding Education Building, Lower Ground Destination Bar)

Thermal Sub-Metering

- Central CHW and HHW Usage
- Education Building CHW and HHW Usage
- Lands Building CHW and HHW Usage

- Education Building Restaurants & Lobby Bar
- Education Building, Lower Ground Destination Bar (for NABERS exclusion)
- Lands Building Commercial F&B, Retail & Kitchen spaces (for NABERS exclusion)
- Lands Building Commercial tenancies (for NABERS exclusion)

Electrical Sub-Metering

- All Lifts (individual sub-meter provided for each lift) – to be confirmed for Lands Building Lifts
- House Services Boards – Lighting and Power
- Mechanical Services Boards – all mechanical services items
- Education Building, Lower Ground Destination Bar (for NABERS exclusion)
- Lands Building Commercial F&B, Retail & Kitchen spaces (for NABERS exclusion)
- Lands Building Commercial tenancies (for NABERS exclusion)

Gas Sub-Metering

- Central Domestic Hot Water Plant (specifically for primary heating for domestic hot water on hydraulic side)
- Central Mechanical Heating Hot Water Plant (inclusive of heating for HVAC, swimming pool, and pre-heating of domestic hot water on mechanical side)
- Education Building, Basement 3 Production Kitchen
- Education Building, Ground Floor Show Kitchen
- Lands Building, whole building gas use meter
- Lands Building, Lower Ground Club Kitchen (for NABERS exclusion)
- Lands Building, Lower Ground F&B Retail (for NABERS exclusion)
- Lands Building, Level 2 Function Kitchen

Domestic Hot Water Sub-Metering

- Education Building, Basement 3 Production Kitchen
- Education Building, Basement 2 Staff Areas
- Education Building, Amenities & BOH & Ancillary Spaces
- Education Building, Level 5 Pool Plant
- Education Building, Level 5 Pool Facility Amenities
- Education Building, Basement Level Supply & Return
- Whole Building for Education Building Supply & Return
- Hot Water Provisions to Lands Building Supply & Return

Refer to Appendix E, BMS Functional Description Report – Section 13 to Section 15 for list of metering provided linked to the BMS system for NABERS Energy Monitoring.

7.2 Data Collection

In accordance with Section 11 of the NABERS Energy and Water for hotels – 'Rules for collecting and using data' (Version 3.2, August 2015), utility bills showing consumption records for the Rating Period must be provided to the NABERS Assessor.

The NABERS rating will be provided at the end of the 12-month rating period. To complete this rating, the NABERS assessor must be provided with the metering data outlined above.

8. Risk Assessment

Risk	Potential Impact	Abatement Approach
Increased occupancy rate & increased food coverages	Higher occupancy rate of the development would intensify the energy consumption of the development. Increased energy usage is anticipated to be associated with increased demand for heating/cooling met by HVAC systems, increased domestic hot water usage and is expected that the kitchen equipment energy use will increase due to higher food coverages.	This will be considered a medium risk as the impact on the NABERS rating is significant. Any increases in energy consumption caused by higher occupancy levels are unlikely to be long term, with seasonal variations causing drop-offs in occupancy.
Climate Change	Generally, this will result in an increase in HVAC energy consumption as the HVAC systems need to operate harder to satisfy the indoor conditions. However the development is capable of adopting with climate change as it is composed of existing building with its external heritage façade preserved. While the development has a significantly high heating demand compared to cooling, the increased average temperature associated with climate change allows the development to benefit from reduced energy consumption for heating.	This is considered a likely occurrence the the impact is mitigated by a trade off in cooling and heating energy. Overall there is little impact to the NABERS rating.
CO2 Sensors	This is a design risk in that the Lands Building design has not been finalised. Should the C02 sensor design not be carried through D&C, it is prudent to test the uplift in fan and conditioning energy associated to constant volume outside air supply to function spaces in the Lands Building.	This risk has been quantified and included in the off-axis scenario. The impact is low.

9. Building Operation Summary

Issue	Comment
HVAC System Performance	All systems are achieving their design criteria. This has been demonstrated through confirming at a minimum: • Temperature is maintained in the occupied spaces for the occupied hours • Outdoor air limits are maintained. • Pump minimum flows are maintained • Chiller COP is in line with stated design • Air and water off-coil temperatures meet the design conditions.
Plant Performance	Boilers and chillers are sized adequately to meet the relevant loads. • Boiler capacity: 2,500 kW (duty) plus 1,250 kW (standby). Max experienced load: 1,047 kW • Chiller capacity: 3,390 kW (duty) plus 1,460 kW (standby). Max experienced load: 1,709 kW

10. Compliance Checklist

Item	Included	Notes
Input Data Validation	Yes	Refer to Section **Error! Reference source not found.**
Metering Requirements Description	Yes	Refer to Section 7.1
Off-Axis Scenarios Listing	Yes	Refer to Section 6.3
Building Operation Summary	Yes	Refer to Section 9
Figures for use in NABERS Energy Rating	Yes	Refer to Section 6
Risk Assessment	Yes	Refer to Section 8
Disclaimer	Yes	Refer to Second Page of report

APPENDIX A Drawing and Documentation

Education Building

Item	Description	Issue	Date
Architectural (WEBBER)	• General Arrangement Plans • Thermal Insulation RCPs • Elevations • Sections	For Construction	Aug 2021
Mechanical Services (Equilibrium)	• Mechanical HVAC Ductwork & Pipeworks Layouts • Schematics (Air, Chilled Water, Hot Water) • Equipment Datasheets • BMCS Functional Description Report • Carrier Chiller Management Report	For Construction	Aug 2021
Hydraulic Services (JRK Group)	• Drainage & Pressure Layout Drawings • Cold Water, Hot Water and Gas Schematics • Hydraulic Equipment Datasheets	For Construction	July 2021
Electrical Services (HeyDay)	• Internal Lighting Layout Drawings • External Lighting Layout Drawings	For Construction	March 2021
Building Fabric	• NCC Section J Part J1 & J2 Report, Rev. 15 (WGE/Stantec) • Façade Performance Specification (TTW) • Sandstone Precinct – Department of Education Building, Lantern Glazing – Structural and Thermal Check (Mott MacDonald) • Sandstone Precinct – Preliminary Façade Thermal Analysis (Core) • Sandstone Precinct ASB Façade FTE-02 Skylight System (Inhabit)	For CC6 For Tender Rev 05 Rev 02 Rev 00	Feb 2021 Aug 2019 Dec 2020 May 2021 May 2021
Swimming Pool (Crystal Pool)	• Pool Schematic Drawings • Pool Equipment Datasheets	For Construction	Feb 2021
Lifts (Schindler Lifts)	• Lift Specification Datasheets	For Construction	Feb 2021

Lands Building

Item	Description	Issue	Date
Architectural Drawings (HASSELL)	• General Arrangement Plans • Thermal Insulation RCPs • Elevations • Sections	100% DD	Feb 2020
Mechanical Services (Stantec)	• Mechanical Services Specification • Mechanical HVAC Ductwork & Pipeworks Layouts • Schematics (Air, Chilled Water, Hot Water)	70% D&C Tender	Feb 2020
Hydraulic Services (Stantec)	• Drainage and Pressure Layout • Gas & Water Schematic	70% D&C Tender	Dec 2019
Electrical Services (Stantec)	• Internal Lighting Layout Drawings • External Lighting Layout Drawings	70% D&C Tender	Dec 2019
Building Fabric	• NCC 2016 Section J Part J1 & J2 Report, Rev. 03 (WGE/Stantec)	Tender Issue	Dec 2019
Lifts (WSP)	• WSP Lands Building Vertical Transportation Specification (Rev. P3)	100% DD	Jan 2020

APPENDIX B Weather File

Location:	Sydney Airport (Amo), Australia [Australia]
Latitude:	33.93° S
Ht. above sea level (m):	5.00
Ground reflectance:	0.20
Local time correction (hrs):	1
From month:	October
To month:	March
Correction for other months (hrs):	0
Longitude:	151.18° E
Time zone:	10
Weather:	
Design weather data source:	ASHRAE design weather database
Design weather location:	Sydney Airport (Amo), Australia
Percentile for Heating Loads:	99.60%
Percentile for Cooling Loads:	0.40%
Ext Winter Design Temp (°C):	6.10
Wind Exposure:	Normal
Terrain Type	Suburbs
Annual climate file:	NSW_Sydney_RO_81_TRY.fwt
Maximum Temperature Levels:	
Dry-bulb (°C)	35.40
Wet-bulb (°C)	22.20

	Dry-bulb (°C)		Wet-bulb (°C)	
	Min	Max	Max	Lag
Jan	28.30	35.10	20.90	3
Feb	28.70	35.10	22.20	3
Mar	24.60	31.20	20.60	3
Apr	21.80	29.40	17.30	3
May	17.70	25.30	16.30	3
Jun	14.20	22.10	14.30	3
Jul	13.70	22.00	12.80	3
Aug	16.20	25.20	13.90	3
Sep	20.90	30.00	15.90	3
Oct	25.30	33.90	17.30	3
Nov	27.60	35.00	19.30	3
Dec	28.30	35.40	19.90	3

APPENDIX C Operational Profiles

Hotel Guest Room – NABERS Default Operating Schedules (Occupancy, Lighting and Equipment)

Time	Weekdays (Mon - Thu)			Fri			Sat			Sun		
	Occupancy	Lighting	Equipment	Occupancy	Lighting	Equipment	Occupancy	Lighting	Equipment	Occupancy	Lighting	Equipment
0:00	90%	30%	20%	90%	30%	20%	100%	31%	21%	100%	31%	21%
1:00	90%	20%	20%	90%	20%	20%	100%	21%	21%	100%	21%	21%
2:00	90%	20%	15%	90%	20%	15%	100%	21%	16%	100%	21%	16%
3:00	90%	20%	15%	90%	20%	15%	100%	21%	16%	100%	21%	16%
4:00	90%	20%	15%	90%	20%	15%	100%	21%	16%	100%	21%	16%
5:00	80%	20%	15%	80%	20%	15%	100%	21%	16%	100%	21%	16%
6:00	70%	20%	40%	70%	20%	40%	87%	21%	42%	87%	21%	42%
7:00	60%	30%	80%	60%	30%	80%	75%	31%	84%	75%	31%	84%
8:00	60%	40%	50%	60%	40%	50%	75%	42%	52%	75%	42%	52%
9:00	30%	40%	30%	30%	40%	30%	37%	42%	31%	37%	42%	31%
10:00	10%	20%	20%	10%	20%	20%	12%	21%	21%	12%	21%	21%
11:00	10%	20%	20%	10%	20%	20%	12%	21%	21%	12%	21%	21%
12:00	10%	20%	20%	10%	20%	20%	10%	20%	20%	10%	20%	20%
13:00	10%	20%	20%	10%	20%	20%	10%	20%	20%	10%	20%	20%
14:00	10%	20%	20%	10%	20%	20%	10%	20%	20%	10%	20%	20%
15:00	10%	20%	20%	10%	20%	20%	10%	20%	20%	10%	20%	20%
16:00	20%	20%	20%	20%	20%	20%	20%	20%	20%	18%	20%	20%
17:00	30%	50%	40%	37%	52%	42%	37%	52%	42%	27%	43%	35%
18:00	40%	60%	40%	50%	63%	42%	50%	63%	42%	36%	52%	35%
19:00	50%	70%	50%	62%	73%	52%	62%	73%	52%	45%	61%	43%
20:00	60%	70%	60%	75%	73%	63%	75%	73%	63%	54%	61%	52%
21:00	70%	60%	60%	87%	63%	63%	87%	63%	63%	63%	52%	52%
22:00	70%	60%	40%	87%	63%	42%	87%	63%	42%	63%	52%	35%
23:00	90%	40%	20%	100%	42%	21%	100%	42%	21%	81%	35%	17%

Hotel Guest Room – NCC 2019 Section J Table 2b Class 3 hotel air-conditioning profile and fan coil unit speed modulation control

Time Period	Air-conditioning (Daily)	Fan Speed Modulation (Daily)
12:00am to 1:00am	ON	30%
1:00am to 2:00am	ON	30%
2:00am to 3:00am	ON	30%
3:00am to 4:00am	ON	30%
4:00am to 5:00am	ON	30%
5:00am to 6:00am	ON	30%
6:00am to 7:00am	ON	60%
7:00am to 8:00am	ON	60%
8:00am to 9:00am	ON	60%
9:00am to 10:00am	ON	60%
10:00am to 11:00am	OFF	0%
11:00am to 12:00am	OFF	0%
12:00pm to 1:00pm	OFF	0%
1:00pm to 2:00pm	OFF	0%
2:00pm to 3:00pm	OFF	0%
3:00pm to 4:00pm	OFF	0%
4:00pm to 5:00pm	OFF	0%
5:00pm to 6:00pm	ON	90%
6:00pm to 7:00pm	ON	90%
7:00pm to 8:00pm	ON	90%
8:00pm to 9:00pm	ON	90%
9:00pm to 10:00pm	ON	30%
10:00pm to 11:00pm	ON	30%
11:00pm to 12:00pm	ON	30%

Common Area (Lobby & Corridor) – NABERS Default Occupancy and Lighting Operational Schedule

Occupancy

Time	Weekday	Weekend
0:00	0%	0%
1:00	0%	0%
2:00	0%	0%
3:00	0%	0%
4:00	0%	0%
5:00	10%	0%
6:00	20%	10%
7:00	50%	20%
8:00	90%	50%
9:00	50%	100%
10:00	30%	50%
11:00	30%	30%
12:00	30%	50%
13:00	30%	50%
14:00	30%	30%
15:00	30%	30%
16:00	30%	30%
17:00	50%	50%
18:00	90%	50%
19:00	50%	50%
20:00	30%	30%
21:00	30%	30%
22:00	20%	30%
23:00	10%	20%

Lighting with Motion Detectors controlling 7+ Fittings

Time	No automatic controls	Motion detectors controlling 7+ fittings
0:00	100%	90%
1:00	100%	90%
2:00	100%	90%
3:00	100%	90%
4:00	100%	90%
5:00	100%	90%
6:00	100%	90%
7:00	100%	90%
8:00	100%	90%
9:00	100%	90%
10:00	100%	90%
11:00	100%	90%
12:00	100%	90%
13:00	100%	90%
14:00	100%	90%
15:00	100%	90%
16:00	100%	90%
17:00	100%	90%
18:00	100%	90%
19:00	100%	90%
20:00	100%	90%
21:00	100%	90%
22:00	100%	90%
23:00	100%	90%

Restaurant / Café / Kitchens / Food Preparation – NCC 2019 Section J Table 2f Class 6 restaurant or café occupancy and operation profile

Time period (local standard time)	Occupancy (Monday to Saturday)	Artificial lighting (Monday to Saturday)	Appliances and equipment (Monday to Saturday)	*Air-conditioning* (Monday to Saturday)
12:00am to 1:00am	0%	5%	15%	Off
1:00am to 2:00am	0%	5%	15%	Off
2:00am to 3:00am	0%	5%	15%	Off
3:00am to 4:00am	0%	5%	15%	Off
4:00am to 5:00am	0%	5%	15%	Off
5:00am to 6:00am	0%	5%	15%	Off
6:00am to 7:00am	5%	40%	40%	Off
7:00am to 8:00am	5%	40%	40%	On
8:00am to 9:00am	5%	60%	60%	On
9:00am to 10:00am	5%	60%	60%	On
10:00am to 11:00am	20%	90%	90%	On
11:00am to 12:00pm	50%	90%	90%	On
12:00pm to 1:00pm	80%	90%	90%	On
1:00pm to 2:00pm	70%	90%	90%	On
2:00pm to 3:00pm	40%	90%	90%	On
3:00pm to 4:00pm	20%	90%	90%	On
4:00pm to 5:00pm	25%	90%	90%	On
5:00pm to 6:00pm	50%	90%	90%	On
6:00pm to 7:00pm	80%	90%	90%	On
7:00pm to 8:00pm	80%	90%	90%	On
8:00pm to 9:00pm	80%	90%	90%	On
9:00pm to 10:00pm	50%	90%	90%	On
10:00pm to 11:00pm	35%	50%	50%	On
11:00pm to 12:00am	20%	30%	30%	On

Conference / Function Room / Boardroom – NABERS Default Occupancy Operating Schedule

Time	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
	No booking	All day	Morning only	Lunch-afternoon	All day	No booking	Evening
0:00	0%	0%	0%	0%	0%	0%	0%
1:00	0%	0%	0%	0%	0%	0%	0%
2:00	0%	0%	0%	0%	0%	0%	0%
3:00	0%	0%	0%	0%	0%	0%	0%
4:00	0%	0%	0%	0%	0%	0%	0%
5:00	0%	0%	0%	0%	0%	0%	0%
6:00	0%	0%	20%	0%	0%	0%	0%
7:00	0%	20%	20%	0%	20%	0%	0%
8:00	0%	20%	80%	0%	40%	0%	0%
9:00	0%	20%	80%	0%	40%	0%	0%
10:00	0%	20%	80%	20%	60%	0%	0%
11:00	0%	40%	60%	40%	60%	0%	0%
12:00	0%	40%	60%	40%	60%	0%	0%
13:00	0%	40%	20%	40%	80%	0%	0%
14:00	0%	40%	0%	40%	60%	0%	0%
15:00	0%	40%	0%	100%	40%	0%	20%
16:00	0%	40%	0%	100%	20%	0%	20%
17:00	0%	20%	0%	100%	20%	0%	40%
18:00	0%	20%	0%	20%	20%	0%	80%
19:00	0%	0%	0%	0%	0%	0%	100%
20:00	0%	0%	0%	0%	0%	0%	80%
21:00	0%	0%	0%	0%	0%	0%	60%
22:00	0%	0%	0%	0%	0%	0%	60%
23:00	0%	0%	0%	0%	0%	0%	20%

Conference / Function Room / Boardroom – NABERS Default Lighting and Power Operating Schedule (note where 15% lighting/power load has been adjusted to 0%)

Time	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
	No booking	All day	Morning only	Lunch-afternoon	All day	No booking	Evening
0:00	15%	15%	15%	15%	0%	15%	15%
1:00	15%	15%	15%	15%	0%	15%	15%
2:00	15%	15%	15%	15%	0%	15%	15%
3:00	15%	15%	15%	15%	0%	15%	15%
4:00	15%	15%	15%	15%	0%	15%	15%
5:00	15%	15%	15%	15%	0%	15%	15%
6:00	15%	15%	90%	15%	0%	15%	15%
7:00	15%	90%	90%	15%	90%	15%	15%
8:00	15%	90%	90%	15%	90%	15%	15%
9:00	15%	90%	90%	15%	90%	15%	15%
10:00	15%	90%	90%	90%	90%	15%	15%
11:00	15%	90%	90%	90%	90%	15%	15%
12:00	15%	90%	90%	90%	90%	15%	15%
13:00	15%	90%	90%	90%	90%	15%	15%
14:00	15%	90%	15%	90%	90%	15%	15%
15:00	15%	90%	15%	90%	90%	15%	90%
16:00	15%	90%	15%	90%	90%	15%	90%
17:00	15%	90%	15%	90%	90%	15%	90%
18:00	15%	90%	15%	90%	90%	15%	90%
19:00	15%	15%	15%	15%	15%	15%	90%
20:00	15%	15%	15%	15%	15%	15%	90%
21:00	15%	15%	15%	15%	15%	15%	90%
22:00	15%	15%	15%	15%	15%	15%	90%
23:00	15%	15%	15%	15%	15%	15%	90%

Office – Green Star Table 27 Office operating schedules (note this table was only referred to for lighting operation profile).

Table 27: Office operating schedules

Hour of Day	Weekday				Weekend			
	Occup	Lighting	Equip	HVAC	Occup	Lighting	Equip	HVAC
1	0%	15%	50%	OFF	0%	15%	50%	OFF
2	0%	15%	50%	OFF	0%	15%	50%	OFF
3	0%	15%	50%	OFF	0%	15%	50%	OFF
4	0%	15%	50%	OFF	0%	15%	50%	OFF
5	0%	15%	50%	OFF	0%	15%	50%	OFF
6	0%	15%	50%	OFF	0%	15%	50%	OFF
7	0%	15%	50%	OFF	0%	15%	50%	OFF
8	10%	40%	65%	ON	0%	15%	50%	OFF
9	20%	90%	80%	ON	5%	25%	55%	OFF
10	70%	100%	100%	ON	5%	25%	55%	OFF
11	70%	100%	100%	ON	5%	25%	55%	OFF
12	70%	100%	100%	ON	5%	25%	55%	OFF
13	70%	100%	100%	ON	5%	25%	55%	OFF
14	70%	100%	100%	ON	5%	25%	55%	OFF
15	70%	100%	100%	ON	5%	25%	55%	OFF
16	70%	100%	100%	ON	5%	25%	55%	OFF
17	70%	100%	100%	ON	5%	25%	55%	OFF
18	35%	80%	80%	ON	0%	15%	50%	OFF
19	10%	60%	65%	OFF	0%	15%	50%	OFF
20	5%	60%	55%	OFF	0%	15%	50%	OFF
21	5%	50%	55%	OFF	0%	15%	50%	OFF
22	0%	15%	50%	OFF	0%	15%	50%	OFF
23	0%	15%	50%	OFF	0%	15%	50%	OFF
24	0%	15%	50%	OFF	0%	15%	50%	OFF
TOTAL	6.45	13.3	17.0	11	0.45	4.5	12.45	0

Office – NCC 2019 Section J Table 2f Class 5 occupancy and operation profile

Time period (local standard time)	Occupancy (Monday to Friday)	Artificial lighting (Monday to Friday)	Appliances and equipment (Monday to Friday)	*Air-conditioning* (Monday to Friday)
12:00am to 1:00am	0%	15%	25%	Off
1:00am to 2:00am	0%	15%	25%	Off
2:00am to 3:00am	0%	15%	25%	Off
3:00am to 4:00am	0%	15%	25%	Off
4:00am to 5:00am	0%	15%	25%	Off
5:00am to 6:00am	0%	15%	25%	Off
6:00am to 7:00am	0%	15%	25%	Off
7:00am to 8:00am	10%	40%	65%	On
8:00am to 9:00am	20%	90%	80%	On
9:00am to 10:00am	70%	100%	100%	On
10:00am to 11:00am	70%	100%	100%	On
11:00am to 12:00pm	70%	100%	100%	On
12:00pm to 1:00pm	70%	100%	100%	On

Time period (local standard time)	Occupancy (Monday to Friday)	Artificial lighting (Monday to Friday)	Appliances and equipment (Monday to Friday)	*Air-conditioning* (Monday to Friday)
1:00pm to 2:00pm	70%	100%	100%	On
2:00pm to 3:00pm	70%	100%	100%	On
3:00pm to 4:00pm	70%	100%	100%	On
4:00pm to 5:00pm	70%	100%	100%	On
5:00pm to 6:00pm	35%	80%	80%	On
6:00pm to 7:00pm	10%	60%	65%	Off
7:00pm to 8:00pm	5%	60%	55%	Off
8:00pm to 9:00pm	5%	50%	25%	Off
9:00pm to 10:00pm	0%	15%	25%	Off
10:00pm to 11:00pm	0%	15%	25%	Off
11:00pm to 12:00am	0%	15%	25%	Off

Plant services area – Green Star Table 37 Back of House operating schedules (note this table was only referred to for lighting operation profile).

Hour of Day	Weekday				Weekend			
	Occup	Lighting	Equip	HVAC	Occup	Lighting	Equip	HVAC
1	0%	10%	10%	OFF	0%	10%	10%	OFF
2	0%	10%	10%	OFF	0%	10%	10%	OFF
3	0%	10%	10%	OFF	0%	10%	10%	OFF
4	0%	10%	10%	OFF	0%	10%	10%	OFF
5	0%	10%	10%	OFF	0%	10%	10%	OFF
6	0%	10%	10%	OFF	0%	10%	10%	OFF
7	0%	10%	10%	OFF	0%	10%	10%	OFF
8	0%	50%	15%	ON	0%	10%	10%	OFF
9	0%	50%	70%	ON	0%	10%	10%	OFF
10	0%	50%	100%	ON	0%	10%	10%	OFF
11	0%	50%	100%	ON	0%	10%	10%	OFF
12	0%	50%	100%	ON	0%	10%	10%	OFF
13	0%	50%	100%	ON	0%	10%	10%	OFF
14	0%	50%	100%	ON	0%	10%	10%	OFF
15	0%	50%	100%	ON	0%	10%	10%	OFF
16	0%	50%	100%	ON	0%	10%	10%	OFF
17	0%	50%	100%	ON	0%	10%	10%	OFF
18	0%	50%	60%	ON	0%	10%	10%	OFF
19	0%	50%	25%	ON	0%	10%	10%	OFF
20	0%	10%	15%	OFF	0%	10%	10%	OFF
21	0%	10%	15%	OFF	0%	10%	10%	OFF
22	0%	10%	10%	OFF	0%	10%	10%	OFF
23	0%	10%	10%	OFF	0%	10%	10%	OFF
24	0%	10%	10%	OFF	0%	10%	10%	OFF
TOTAL	0	7.2	11.0	12	0	2.4	2.4	0

Predicted Potable Water Pump Operational Schedule

Time Period	Wkday	Sat	Sun
12:00am to 1:00am	30%	30%	30%
1:00am to 2:00am	30%	30%	30%
2:00am to 3:00am	30%	30%	30%
3:00am to 4:00am	30%	30%	30%
4:00am to 5:00am	30%	30%	30%
5:00am to 6:00am	50%	50%	50%
6:00am to 7:00am	70%	70%	70%
7:00am to 8:00am	90%	90%	90%
8:00am to 9:00am	100%	100%	100%
9:00am to 10:00am	100%	100%	100%
10:00am to 11:00am	100%	100%	100%
11:00am to 12:00am	100%	100%	100%
12:00pm to 1:00pm	100%	100%	100%
1:00pm to 2:00pm	100%	100%	100%
2:00pm to 3:00pm	100%	100%	100%
3:00pm to 4:00pm	100%	100%	100%
4:00pm to 5:00pm	100%	100%	100%
5:00pm to 6:00pm	100%	100%	100%
6:00pm to 7:00pm	100%	100%	100%
7:00pm to 8:00pm	100%	100%	100%
8:00pm to 9:00pm	100%	100%	100%
9:00pm to 10:00pm	100%	100%	100%
10:00pm to 11:00pm	70%	70%	70%
11:00pm to 12:00pm	70%	70%	70%

Predicted Sewer Pump Operational Schedule

Time Period	Wkday	Sun
12:00am to 1:00am	Wkday	Sat
1:00am to 2:00am	0%	0%
2:00am to 3:00am	0%	0%
3:00am to 4:00am	0%	0%
4:00am to 5:00am	0%	0%
5:00am to 6:00am	0%	0%
6:00am to 7:00am	0%	0%
7:00am to 8:00am	0%	0%
8:00am to 9:00am	100%	0%
9:00am to 10:00am	100%	0%
10:00am to 11:00am	100%	100%
11:00am to 12:00am	100%	100%
12:00pm to 1:00pm	100%	100%
1:00pm to 2:00pm	100%	0%
2:00pm to 3:00pm	100%	0%
3:00pm to 4:00pm	100%	0%
4:00pm to 5:00pm	100%	0%
5:00pm to 6:00pm	100%	0%
6:00pm to 7:00pm	100%	0%
7:00pm to 8:00pm	100%	0%
8:00pm to 9:00pm	0%	0%
9:00pm to 10:00pm	0%	0%
10:00pm to 11:00pm	0%	0%
11:00pm to 12:00pm	0%	0%

APPENDIX D Mechanical Schematic, Equipment Schedules & Chiller COP Data

APPENDIX E BMS Functional Description Report & Chiller Management Report

APPENDIX F Hydraulic Schematic

APPENDIX G Façade Report

APPENDIX H Energy Coverage

APPENDIX I Ancillary Ventilation System Detailed Energy Calculation

APPENDIX J Internal Lighting System Detailed Energy Calculation

Design with
community in mind

Level 6, Building B
207 Pacific Highway
St Leonards NSW 2065
Tel +61 2 8484 7000

For more information please visit
www.stantec.com

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