Sensitivity: General

Green Star - Buildings NZv1.0

ENERGY USE CALCULATION GUIDE

DECEMBER 2024

This guide has been adapted from the Green Building Council of Australia's guide. This guide is to be used for Credit 22 Energy Uses, Reference Project Pathway and Credit 20 Grid Resilience.

greenstar

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Change Log

Release	Date	Description of changes
Green Star – Design & As Built v1.0	16/10/2014	Initial Release in Australia.
Green Star – Design & As Built NZ v1.0	11/04/2019	Initial Release in New Zealand.
	21/02/2020	Include calculation guide for Interiors reference fitout pathway.
	4/11/2020	Add the following missing sections back Section14.4.3,14.4.4 and 14.4.5
		Revise the definition for Intermediate Building and Reference Project
		Remove IWEC pathway from the climate profile
		Make reference to NIWA ground water data for make up water temperature
		Remove unnecessary reference to NCC section J.
		Update HVAC system parameters for Reference and Intermediate projects in Table 64
		Other minor corrections
Green Star – Design & As Built NZ v1.1	08/2022	Removal of Intermediate and Benchmark Models
		Clarification of process scope and allowable simplifications
		Update to HVAC definition to align with NZBC and component-based efficiency requirements
		Inclusion of Shared Services from the Credit Template
		Updated Carbon Factors
Green Star - Buildings	12/2024	Removal references to GHG Emissions.
		Removal of references to GS Interiors Tool
		Update to Peak Demand reduction section to reflect Grid Resilience Credit

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1 INTRODUCTION

This document sets out the basis on which project energy performance modelling is to be completed for all *Green Star - Buildings NZ* rating assessments. The methodology is based on the Clause H1 Energy Efficiency of the New Zealand Building Code and the Australian NCC Section J Verification Method JV3, with specific modifications to the methodology and the reference definitions to suit better the objectives of Green Star and typical New Zealand practice.

The main areas of focus in developing this guidance are as follows:

- Provide definite guidance on the requirements for modelling of project energy performance, in terms of end use inclusions and key considerations;
- Provide flexibility to the project team to adjust default operating profiles where appropriate to reflect better the anticipated operation of the project;
- Provide meaningful information from the energy analysis model to inform the ongoing monitoring management of project energy performance; and
- Consolidate existing guidance into a single comprehensive reference document applicable to all Green Star Buildings rating assessments.

2 DEFINITIONS

Carbon Dioxide Equivalent

Carbon dioxide equivalent (CO_2e) is a measure used to compare the emissions from various greenhouse gases based upon their global warming potential (GWP). The carbon dioxide equivalent for a gas is derived by multiplying the mass of the gas by the associated GWP (EPA, 2009). For the purposes of the Green Star rating tools, carbon dioxide equivalents are expressed as kilograms of carbon dioxide equivalent ($kgCO_2e$).

Greenhouse Gas Emissions Factor

Greenhouse gas emissions factors quantify the amount of greenhouse gas (in terms of carbon dioxide equivalent) which will be emitted into the atmosphere, as a result of using one unit of energy, i.e. the amount of greenhouse gas emitted due to using one kilowatt hour of electricity or one megajoule of gas, coal or bio-fuel ($kgCO_2e$/kWh, or $kgCO_2e$/MJ).

Global Warming Potential

Global warming potential (GWP) is defined as the cumulative radiative forcing effects of a gas over a specified time horizon resulting from the emission of a unit mass of gas relative to a reference gas (EPA, 2009). For the purpose of Green Star rating tools, the time horizon is 100 years and the reference gas is carbon dioxide. This is consistent with international greenhouse gas emissions reporting under the Kyoto protocol (IPCC, 1996). For example, methane has a GWP of 21; therefore one tonne of methane released into the atmosphere has the same warming effect, over 100 years, as 21 tonnes of carbon dioxide.

Mechanical Ventilation

Describes the provision of controlled amounts of ventilation (outside) air by the use of mechanical equipment, typically comprising fans, filters, ductwork and terminal air devices. The temperature of the ventilation air may be controlled, but this is not required to be classified as mechanical ventilation.

Mixed-Mode Ventilation

Describes a mode of building control in which mechanical ventilation is used at low and high ambient temperature conditions, and natural ventilation is used at intermediate temperature conditions. The mechanical ventilation mode is typically coupled with temperature control by air conditioning, but this is not always the case.

NZBC Clause H1

Clause H1 Energy Efficiency of the New Zealand Building Code includes minimum energy efficiency requirements for building envelope performance, artificial lighting, and HVAC (for commercial only).

National Construction Code

Section J of the Australian National Construction Code (NCC) Volume One (referenced as NCC Section J in this document) addresses energy efficiency requirements for buildings, and sets the minimum standard of performance required for new construction in Australia. Where efficiency requirements or modelling protocols are not adequately specified within NZBC, the NCC has been used as a reference. References to the NCC in this document are based on multiple NCC versions to reflect the current state of best practice building design and performance modelling within the NZ building industry.

NZ Deemed to Satisfy Criteria

For NZ based projects, the Deemed to Satisfy criteria draws on both NCC (multiple versions) and NZBC Clause H1 requirements (including HVAC requirements, which shall be applied to all building types).

Natural Ventilation

Describes the provision of uncontrolled amounts of ventilation (outside) air by the use of openings in the building envelope which are connected to the occupied space. The movement of air is controlled only by the prevailing environmental conditions, of which the main factors affecting ventilation are wind speed and direction and temperature difference between indoors and outdoors. Openings may be automatically or manually controlled.

Process Loads

A process load is defined as the load on a project resulting from the consumption of energy by a manufacturing, industrial or commercial process, and are unrelated to lighting, heating, ventilation, cooling and water heating or the comfort of occupants. They are categorised as equipment loads, ventilations requirements and temperature requirements.

Project Scope

All areas and activities in a project that have been registered for Green Star. This includes all buildings and any ancillary areas such as parking, landscaping and shared facilities.

Proposed Project

The building or fitout works to be rated by the Green Star - Buildings rating tools, as designed and modelled by the Green Star project team.

Reference Project

A hypothetical building of the same size, shape and floor area as the Proposed Project, but whose building fabric and building services characteristics are based predominantly on the Deemed-to-Satisfy provisions as defined in this document.

Scope 1, 2 & 3 Emissions

Scope 1 emissions are direct greenhouse gas emissions which occur due to activities within an organisation's boundary. Scope 2 and 3 emissions are indirect greenhouse gas emissions which occur due to activities outside of an organisation's boundary. The Scope 1 emissions that are calculated by the GHG Emission Calculator include the direct emissions due to the combustion of fuel on-site, such as the combustion of gas in a project's heating hot water or cogeneration system(s). Scope 2 emissions are those which result from the generation of electricity used by the project. Scope 3 emissions include the indirect emissions that result from the processing and transportation of fuels used within the project.

3 POSITIVE CATEGORY

Green Star – Buildings

The *Green Star - Buildings* Positive category includes the Energy Use, Energy Source and the Grid Resilience credits.

When applying the modelled performance pathway, the same project energy performance model is used as the basis of assessment for these credits. This document describes the required attributes of the project energy performance models used to assess performance. The Green Star Energy Use calculator automatically calculates the points achieved by the project based on project energy performance model output data modelled using approved software.

For the modelled performance pathway energy reduction is calculated based on comparison of the Reference Project and the Proposed Project. As per the definitions of these, all design variables are reflected in this comparison, including services design strategy and choice of energy sources.

Based on the completed energy performance analysis, the peak electricity demand reduction is calculated by entering the Reference and Proposed Project peak electricity demand data into the Green Star Energy Use calculator.

4 ENERGY PERFORMANCE CALCULATION OVERVIEW

4.1 National Construction Code (Australia) Section J

NCC Section J provides three pathways for demonstrating compliance with Performance Requirement JP1 of Section J for Class 3 to Class 9 buildings, namely:

- Deemed-to-Satisfy based on adopting the prescriptive requirements outlined in Parts J1 to J7;
- Verification Method JV3 based on adopting the prescribed performance-based assessment methodology; and
- Alternative Solutions which may be adopted subject to the approval of the Building Surveyor.

Performance assessment methodology (JV3) provides a sensible basis from which to develop a Green Star-specific energy model. This methodology is adopted by the Green Star - Buildings rating tools as the basis of the modelled performance pathway (known as Reference Project) for the Positive Category.

4.2 Australian Building Codes Board Simulation Protocol

Projects adopting the Verification Method JV3 shall utilise a dynamic thermal simulation software package which satisfies the requirement of the Australian Building Code Board's Protocol of Building Energy Analysis Software (v2006-1) (ABCB, 2006). The ABCB does not maintain a register of complying software, but software previously documented to have demonstrated compliance with the Protocol requirements includes (BC, 2006):

- Beaver (developed by ACADS-BSG);
- EnergyPlus (developed by LBNL and DOE);
- Tas (developed by EDSL);
- IES <VE> (developed by IES);
- IDA ICE (developed by Equa Solutions);
- TRACE 700 (developed by Trane CDS); and
- HAP E20-II (developed by Carrier).

The protocol requirements are adopted by the NZGBC as the basis of demonstrating the suitability of software for completing the assessments detailed in this document. Projects using software other than those in the above list must demonstrate that the requirements of the Protocol are satisfied as part of the credit submission. In all cases, the project team must demonstrate how the requirement for training has been satisfied.

4.3 Use of Software and Other Calculation Methods

For the purposes of Green Star, the software must be used for the calculation of all air conditioning system loads (i.e. air side coil loads) and energy consumption. So far as practicable, the software must also be used for the calculation of all HVAC plant loads and associated energy consumption. However, it is recognised that all software packages have limitations and that some system components and/or arrangements may not be able to be assessed by the software directly. Where this is the case, the project team may use supplementary manual calculations (such as in a spreadsheet), but all components that have been calculated in this way must be disclosed, and a description of the methodology given, including commentary on any limitations of the methodology and their effect on the results of the calculation. Where the associated energy consumption and/or greenhouse gas emissions reduction for the associated end use represents a significant proportion (greater than 20%) of the total reduction, the Assessors may request further information to confirm that the methodology is appropriate and consistent with the rest of the model.

For Interiors ratings, it is recognised that the majority of energy consumption will generally be attributable to non-HVAC energy end uses, and it is therefore expected that the majority of calculations will be completed by means other than the use of the energy analysis software detailed above. This is acceptable, but project teams must provide a description of the basis of calculation for each end use, particularly process loads, and demonstrate that the same calculation method has been used for both the Proposed and Reference Projects in each case. Note that it is still required that all calculations of air conditioning-related energy consumption and daylight-linked artificial lighting energy consumption use the methods described in this guide.

4.4 Simplification of Modelling Methodology

Projects may simplify the modelling methods and supplementary calculations included within this guidance to reduce compliance effort. All simplifications must be disclosed, a description of the simplified methodology provided, including commentary clearly showing that the simplification results in a more conservative assessment, being a reduction in the energy and GHG emissions improvements claimed.

Acceptance of a simplified approach is solely at the discretion of the NZGBC. A Technical Question may be raised to support early confirmation of modelling approach.

4.5 Approach to Energy Reduction Calculation

For the purposes of the assessment of performance for the Positive category, projects must adopt a methodology consistent with the Verification Method JV3 approach. However, for the purposes of uniformity and appropriateness of assessment, this guidance document sets out alternative requirements for some parts of the assessment methodology that MUST be implemented for consistent equitable assessment of points awarded to all projects.

The specific calculation requirements are specified in Section 6 and the associated appendices.

5 INTERDEPENDENCE WITH OTHER GREEN STAR CREDITS

5.1 Verification and Handover

Monthly benchmarks by sub-meter are to be included in As Built documentation and actual operational figures shared with NZGBC.

5.2 Light Quality

Where credit is claimed for dimming control of artificial lighting in response to measured daylight in a space, other than by use of the deemed adjustment factors in Section 13.6.2, it must be demonstrated:

- If hourly internal daylight levels are calculated by the energy performance simulation software from first principles, that all inputs to the simulation model are consistent with the inputs to the daylight model; or
- If daylight compensation is calculated by the energy performance simulation software based on daylight factor and solar radiation data, that all daylight factors entered correlate to the calculated daylight factor distribution. This must include consideration of the depth of the daylit area relative to the HVAC zone and the position of the daylight sensor within the zone.

5.3 Quality of Indoor Air

Ventilation rates (that is the quantity of outdoor air introduced to the project) and the method of ventilation control as applied in the Clean Air credit must be consistent with the quantities and controls claimed in this credit. Where demand-controlled ventilation is applied based on the use of carbon dioxide (CO_2) sensors, then this must be modelled using one of the following approaches, and with the CO_2 concentration set point in accordance with credit Clean Air:

- In single-zone systems (including systems serving multiple instances of spatially uniform occupancy, e.g. open plan office spaces) the reduction in outdoor air flow rate may be assumed to be proportional to the reduction in space occupancy based on the following equation:

$$p_{OA} = 100\% - 0.8(100\% - p_{occ})$$

Where $\mathrm{p_{OA}}$ is the percentage of design outdoor air supplied to the space, and $\mathrm{p_{occ}}$ is the percentage of design occupancy for any given hour of HVAC system operation. The factor of 0.8 is included to compensate for actual variability in occupancy between zones and imperfect control of dampers which will not maintain proportionality across the control range.

- In multi-zone systems, the calculation must be based on dynamic application of AS1668.2.2012 or ASHRAE, 2010 multiple enclosure rules.

Where the approved modelling software does not calculate the rate of bioeffulent automatically, the rate of bioeffluent CO_2 emission to the space shall be based on the following equation (NIST, 2001):

$$\dot{q}_{CO2} = \frac{0.00276 A_D M Q_R}{0.23 Q_R + 0.77}$$

Where $\dot{q}_{CO2}$ is the rate of CO_2 emission (L/s/person), A_D is the duBios body surface area (m²) (approx 1.8 m² for typical adults), M is the occupant metabolic activity rate (met), and Q_R is the respiratory quotient (the relative volumetric rates of carbon dioxide produced to oxygen consumed) (approximately 0.83 for sedentary-to-light activity, and increasing to 1.0 for heavy physical activity (5 met)). The occupant activity level used for each space type must be consistent with the inputs used for the Thermal Comfort credit; assume $A_D = 1.8$ m^2 and linear variation of Q_R from 0.83 at 1.2 met and below, to 1.0 at 5 met and above.

5.4 Thermal Comfort

Thermal comfort and project energy performance assessments should ideally be completed in the same software package using all of the same model inputs. However, where this cannot be done, the software used for both assessments must comply with the software requirements of this guide, and all of the same input parameters must be applied in both simulations.

5.5 Water

Domestic hot water usage for the Reference and Proposed Projects must be based on the calculations completed in the Potable Water calculator. The calculator provides an annual total usage figure only; the project team must convert this to an hourly usage profile for use in conjunction with the simulation model. Guidance on water consumption profiles is provided in Section 6.9.

Heat rejection water consumption for the Reference Project is calculated by the Potable Water calculator based on monthly total heat rejection values; these values must be calculated from the simulation output, if not available directly. Project teams must differentiate between wet heat rejection (from water-cooled chillers) and dry-heat rejection (from air-cooled chillers and air-source heat pumps).

Heat rejection water consumption for the Proposed Project is calculated by the Potable Water calculator based on monthly total heat rejection values, where conventional evaporative cooling towers are used. If the Proposed Project uses alternative heat rejection technology (such as adiabatic coolers) then the water consumption must be calculated as part of the energy performance simulation and the total usage value entered into the Potable Water calculator.

Where direct or indirect evaporative cooling systems are used in the Proposed Project, the associated water consumption must be calculated as part of the energy performance simulation and the total entered into the Potable Water calculator.

6 CALCULATION REQUIREMENTS

6.1 Scope of Energy End Use Inclusions

The following end uses must be included in assessment of the project's energy consumption, as a minimum:

- All HVAC systems for control of the internal environment, including server, communications, equipment and electrical rooms;
- All HVAC systems for control of processes, where these are provided as part of the services engineer's scope of works;
- All internal and external artificial lighting, including task lighting, provided as part of the services engineer's scope of works;
- All water supply and treatment systems, including cold water pressurisation, domestic hot water heating, rainwater distribution, grey- or blackwater treatment and distribution (including reverse osmosis, ultraviolet or other filtration systems);
- Vertical and horizontal transportation systems, including lifts, escalators and moving walkways;
- Specialist services systems provided as part of the services engineer's scope of works, for example medical gases, pneumatic tube system and steam generators in healthcare buildings.

- All swimming pool plant systems, including water heating, circulation pump(s), and underwater lighting. This includes general swimming pools and spas in leisure centres, gymnasia and residential buildings, and specialist pools, e.g. hydrotherapy pools.

Note that lift and domestic hot water energy consumption must be included in both the Proposed and Reference Project energy consumption.

6.1.1 Process Load

Where process loads (equipment, temperature, or ventilation requirements) impact on either airside or waterside building HVAC systems, this impact shall be included in both the Proposed and Reference Project energy consumption.

6.1.1.1 Process Equipment

Space conditioning loads due to process equipment must be accounted for, whether as airside or waterside system loads, but direct energy consumption due to operation of the process is not included, except for appliances in residential projects (BCA Class 2). The definition of process equipment includes, but is not limited to:

- Computers and similar IT equipment in office-type work environments;
- IT and communications equipment in server rooms, data centres and communications rooms;
- Specialist healthcare equipment such as MRI, CT, PET and X-ray imaging equipment;
- Commercial catering operations. Note that the associated kitchen ventilation systems are NOT process equipment and must be included as per Section 6.1.1.3;
- Commercial laundry operations. Note that the associated ventilation systems are NOT process equipment and must be included in the calculation as per Section 6.1.1.3;
- Refrigerated display cabinets in food retail premises;
- Heating and cooling of, plunge pools, saunas and steam rooms in leisure facilities (the heat load in adjacent conditioned spaces must account for the temperature differential between them). Note that the associated ventilation systems are NOT process loads and must be included in the calculation; and
- All industrial manufacturing processes
- Specialist lighting for growth of organic material
- Specialist AV equipment used for public displays
- Specialist lighting for performance, sports, or broadcast events

Where the process equipment loads are treated by completely independent HVAC systems and do not impact on base building HVAC systems the space conditioning loads may be excluded from both the Proposed and Reference Projects. Examples include:

- IT and communications equipment in a server room that is conditioned via an independent DX split system may be excluded;
- Specialist healthcare equipment that is provided with its own direct cooling systems – only include residual heat gains into the space.
- Refrigerated display cabinets with external heat rejection systems – only include residual heat gains / cooling into the space.

6.1.1.2 Process Temperature

Process temperature requirements must be accounted for in both the Proposed and Reference Project energy consumption unless a fully independent conditioning system is provided and the conditioned space is separated from adjacent spaces. Examples of a fully independent system include:

- Operation of freezer rooms, cool rooms and hot rooms in laboratories, warehouses and similar (the heat load in adjacent conditioned spaces must account for the temperature differential between them)

6.1.1.3 Process Ventilation

Process ventilation shall be included in both the Proposed and Reference models with any energy associated with fans, additional outdoor air volumes, and space conditioning impacts included, subject to the Proposed and Reference Project HVAC definitions. Examples include:

- Increased ventilation rates for healthcare contaminant control
- Increased ventilation rates for pressurisation of spaces
- Kitchen extracts
- Specialist extract systems

Where process ventilation requirements are used intermittently and directly controlled by the user for a specific task (e.g. laboratory fume cupboards, welding extracts, etc) they may be excluded from both the Proposed and Reference Projects.

6.1.2 Onsite Generation

Where present, on-site (i.e. contained within the title boundary of the premises being rated, and directly connected on the building side of the authority electricity meter) energy generation systems may be included, including both primary and ancillary energy inputs and energy outputs as applicable. 100% of the calculated energy contribution may be included in the assessment. Calculations must be completed in accordance with the methodology specified in this guidance document for the relevant technology.

6.1.3 Shared Services

Buildings which connect to low-carbon energy sources at a utility-scale (as opposed to onsite) are able to include benefits in the assessment energy use. This includes:

- District thermal networks.
- Shared combined heat and power systems.
- Private wire networks with embedded renewable energy.
- Grid connected low-carbon energy (e.g. biomass or biogas systems).

Other options may be available to projects through a Technical Question. Please contact the NZGBC for more information.

Refer to Shared Services and Low-Carbon Energy Supply Assessment Guidelines for additional details.

6.2 General Modelling Criteria

The following table defines the main features of the Proposed and Reference Projects to be used in the simulation model to assess the associated energy use

The information in this section shall be read in conjunction with the supplementary definitions contained in Section 13.

Table 1: Modelling requirements for the Proposed and Reference Project

Item	Description	Proposed Project	Reference Project
1	Thermal calculation method	A thermal calculation method that complies with ABCB, 2006.	As Proposed Project model.
2	Location (selection of climate file)	One of the following options, listed in order of preference: ▪ NIWA source data in Typical meteorological year (TMY) format if the project location is within 50 km of a TMY location for the same climate zone; or ▪ In the absence of local TMY weather data, an actual year of recorded weather data from a location within 50 km of the project location for the same climate zone; or ▪ In the absence of TMY or actual weather data within 50 km, interpolated data based upon 3 points within 250 km of the project location. Please contact the New Zealand Green Building Council for approval of alternative climate files if the project cannot comply with any of the above options.	As Proposed Project model.
3	Adjacent structures and features	Overshadowing from the surrounding environment must be taken into account in the model. Existing adjacent buildings, including any already under construction, must be included in the model; proposed projects on adjacent sites must be excluded if construction has not already commenced at the time of registration of the project.	As Proposed Project model.
4	Environmental conditions	Factors such as ground reflectivity, sky and ground form factors, and temperatures of external bounding surfaces must be specified appropriately for the local conditions.	As Proposed Project model.
5	Orientation	The representation of the Proposed Project orientation shall be consistent with the design documents.	As Proposed Project model

6	Geometric model	The representation of Proposed Project's geometry shall be consistent with the design documents.	As Proposed Project model
7	Building envelope	The simulation of the Proposed Project envelope shall be consistent with the design documents. Manual fenestration shading devices such as blinds or shades shall not be modelled. Automatically controlled shading device e.g. solar control blinds, external louvres etc. shall be modelled as specified and controlled to be in an open/closed position as determined by incident solar radiation as specified.	External feature shading which has been included in the Proposed Project specifically for the control of solar radiation entering the building shall be excluded from the Reference Project. Shading that occurs due to intrinsic features of the building form, such as reveals and returns in the building structure, and balconies or other amenities, can be included in a consistent approach between both the Proposed and Reference Project. Where boundary conditions are defined for the Proposed Project which are not based directly on the hourly weather data, the same boundary conditions must be applied for the Reference Project. Manual fenestration shading devices such as blinds or shades shall not be modelled. Building thermal envelope to meet NZBC Clause H1/AS1 and H1/AS2 schedule method minimum thermal requirements for all conditioned spaces only. Low height space types (e.g. offices, circulation): Glazing window to wall ratio (WWR) shall equal 50% of the above grade perimeter external wall area of conditioned spaces, and shall be distributed uniformly across each external wall where glazing is present in the Proposed Project Model. OR Tall space types (e.g. Warehouse, manufacturing space): Glazing WWR shall equal that of the Proposed Project Model or 50% of the above grade perimeter external wall area of conditioned spaces, whichever is smaller, and shall be distributed uniformly across

			each external wall where glazing is present in the Proposed Project Model. AND The WWR calculation should be based on external wall area adjacent only to conditioned spaces. Glazing SHGC (g-value) = 0.87 Skylight area shall equal that of the proposed project or 5% of the roof area to conditioned spaces, whichever is smaller. Skylight SHGC (g-value) = 0.87
8	External surfaces solar absorptance	As specified within design documents plus 0.05; or, if not specified, 0.65 for walls and 0.75 for roofs.	Solar absorptance of 0.6 for walls and 0.7 for roofs
9	Infiltration rate	Infiltration must be modelled to reflect the air tightness testing results as per the Verification and Handover Credit. Infiltration rates used for modelling prior to air tightness testing must be justified based on the façade design and then updated based on testing results.	0.5 ACH 24 hours/day/7 days a week for all spaces
10	Project operation	Operation should be specified based on the default operating profiles included in Section 13.3 for the relevant space types. The simulation must incorporate variations for all day types as appropriate. Public holidays applicable to the project location shall be included in the simulation, and, unless specifically stated otherwise, will use the weekend or Sunday profile. Where the anticipated operating hours of the Proposed Project differ from the default operating hours, the project team may adjust them to better align with expectations. Where operation is varied by more than 10% of total default operating hours, this must be confirmed with	As per the Proposed Project, except where profiles are specifically modified to reflect design features of the Proposed Project. Operating hours must be the same in both models.

		the NZGBC by a technical question prior to implementation in the model, and must be supported by design documentation or a statement from the client confirming the operational intent. Where the Proposed Project incorporates design features which are expected to vary the operating profiles from the default (such as automatic control features for equipment), the project team may submit a technical question requesting a change for the Proposed Project only. The technical question must include supporting evidence demonstrating why the change is justified.	
11	HVAC zones	The simulation of the Proposed Project HVAC zones shall be consistent with the design documents.	As Proposed Project model
12	Heating, Ventilation and Air Conditioning	The Proposed Project HVAC system type and configuration must be modelled based on the documented design. The simulated internal gains must be in accordance with Section 13.2. Where variable volume control is specified, part-load fan power shall be modelled using one of the methods in Section 13.5.15.1. All ventilation-only systems (e.g. in car parks, loading docks and warehouses) must be included in the energy consumption. Section 13.3 contains operational profiles which must be used for these system types. Where a system includes HEPA filters or other high-pressure drop components required for the process served, system fan power must include the effect of this component(s); the associated energy consumption of these components must be included in the calculation. Credit may be taken for installing atmospheric contaminant monitoring systems and variable-speed fan control in car parks and loading docks by using the Adjustment Factor given in Section 13.6.1.	The Reference Project HVAC system type, configuration and performance parameters must be as specified in Section 0. The design internal gains must be the same as for the Proposed Project; refer to Section 13.1 for further details. The simulated internal gains must be the same as for the Proposed Project, except where additional control features are included in the Proposed Project. Those spaces in the Proposed Project which are mechanically ventilated (such as car parks, loading docks and warehouse spaces), shall be fully mechanically ventilated (i.e. with no passive supply/passive exhaust). Fan energy shall be based on the performance parameters as specified in Section 05. Use the same mechanical extract operation schedules as in the Proposed Project Model.

		For any areas of the building which are only fitted out to shell and core standard, a notional fit out must be modelled on the basis of the most energy intensive fit out allowable by the New Zealand Building Code Clause H1 Energy Efficiency and referenced New Zealand Standards (code compliance minima), or according to the lease agreement or tenant fitout guide. The design team must demonstrate the design provision (e.g. space allowance) that has been made for accommodating the system type modelled.	
13	Artificial internal lighting	Lighting power density as specified for each space type. Lighting operating schedule as indicated in Section 13.3. Credit may be taken for lighting zoning and automatic controls which exceed the requirements of NCC Part J6 (2013); refer to Section 13.6.2.	For each space type use lighting power density limits defined in NZS:4243.2 Table 1. For any space types not listed in NZS:4243.2 Table 1 use lighting power density calculation (NZS:4243.2 Section 3.4.9) with reference to AS/NZS 1680.2 maintained illuminance levels to determine lighting power density limit If the exact space type isn't listed in AS/NZS 1680.2, select most appropriate space type and associated maintained illuminance level. The same operating profiles must be used as are used in the Proposed Project (given in Section 13.3).
14	Artificial external lighting	The annual energy consumption from external artificial lighting must be calculated on the basis of the proposed level of external artificial lighting provided with the daily profiles given in Section 13.3. All external lighting within the project title boundary, but excluding emergency lighting, must be included in the Proposed Project energy consumption calculation (this includes landscape and decorative lighting). Where the Proposed Project design lighting levels do not meet the horizontal illuminance requirements as per SA, 2005, the power density used in the energy consumption calculation must be the greater of:	The annual energy consumption from the external lighting shall be calculated with the external lighting power density given in Section 13.5.25.2, and the same daily profiles as used in the Proposed Project. The same external areas shall be illuminated in the Reference Project as for the Proposed Project excluding any landscape, decorative and emergency lighting. To establish which standard practice power density should be used for a particular area, the lighting designer must

		▪ The proposed design lighting power density; or ▪ The reference lighting power density given in Section 13.5.25.2 for the applicable lighting type category. (This ensures that providing poor lighting amenity is not rewarded in this credit as an energy-saving measure.)	identify the 2 appropriate category from SA, 2005.
15	Domestic hot water systems It is necessary to complete the Potable Water Calculator before the energy consumption from the Proposed and Reference Project domestic hot water system(s) can be calculated.	The domestic hot water usage of the Proposed Project is calculated by the Potable Water Calculator. The domestic hot water usage of the Proposed Project depends on the water efficiency of the taps and showers. Reduction in the volume of domestic hot water usage by installing water efficient fittings is one way to reduce greenhouse gas emissions associated with the project. Where make up water is provided from the mains water service, the water temperature shall be based on the [NIWA ground water data]() for the climate zone applicable to the building location. Where from another source, the project team shall make appropriate assumptions which must be stated in the submission. The contribution due to solar thermal water heating shall be calculated based on the methodology described in Section 7.2.	As with the Proposed Project, the domestic hot water usage of the Reference Project is calculated by the Potable Water calculator. The domestic hot water heating system shall generally be of the same type or types (where multiple systems exist) as for the Proposed Project. Make up water temperature shall be the same as for the Proposed Project. Use a domestic hot water generation system thermal efficiency of 90% Do not account for any waste heat recovery. Do not account for any solar thermal hot water generation.
16	On-site energy generation	100% of the energy generated on-site from low or zero carbon sources, such as cogeneration, trigeneration, solar photovoltaic and wind, may be used to reduce the calculated annual energy consumption of the project. The modelling methodology for any such systems shall be as described in Sections 1.1 or 7, as applicable. Where a diesel generator is installed, it must be assumed that standard diesel, rather than any alternative liquid fuel, is used, unless the generator has been modified to accept the alternative fuel only.	None

17	Lifts	Modelled using the standard calculation methodology detailed in Section 13.5.3.3.	Modelled using the standard calculation methodology detailed in Section 13.5.3.3.
18	Other energy consumption	All services required for the operation of the project must be included in the energy consumption. Any other energy consumed on site for base building facilities such as a water-recycling treatment plant, must be included. All assumptions used in the calculation must be provided in the documentation and justified.	None
19	Small power and process loads	The direct energy consumption by small power or process equipment is not included in the assessment, except for non-communal residential spaces, refer to item 20. This energy consumption is related to the function of the project rather than the physical attributes of the building fabric and services which is being assessed in this credit. However, the internal heat gains resulting from operation of the equipment must be included in the simulation of the HVAC energy consumption as detailed in Section 13.2.	As Proposed Project model.
20	Appliances Applicable to Residential parts of projects (NZBC Non-Communal Residential)	Energy consumption of appliances and equipment must be included in the project energy consumption, as follows: ▪ Refrigerators/freezers; ▪ Dish washers; ▪ Clothes washers; and ▪ Clothes dryers. The energy consumption shall be taken as the energy rating of the appliance (normalised energy consumption in kWh/annum). Refer to www.energyrating.gov.au If only some of the above appliances are being provided as part of the apartment fitout, then for those appliances not being provided, the same energy performance as for the Reference Project shall be assumed. All other appliances are considered small power.	Refer to Section 13.5.45.4 for energy consumption standards applicable to the Reference Project

20	Swimming pools	The make up water requirement for a swimming pool, and the associated heat load for heating of makeup water, is a function of water evaporation from the pool water surface and backflushing of filters. The project must estimate daily heating loads due to this water heating requirement. Where make up water is provided from the mains water service, the water temperature shall be based on the NIWA ground water data for the climate zone applicable to the project location. The contribution due to solar thermal water heating shall be calculated based on the methodology described in Section 7.2. Pump hours of operation and timing of backflushing cycles used in calculations must be justified by the design team. For internal pools, all other heat loss pathways may be ignored; for heated external pools, calculation of ground conduction, surface convection and body radiation heat transfer must be included.	The following attributes of the swimming pool shall be as per the Proposed Project: ▪ Swimming pool water volume and surface area; ▪ Water design temperature (except all outdoor pools are assumed to be unheated); ▪ Hours of operation of swimming pool; ▪ Pool make up water temperature The following apply to the Reference Project swimming pool: ▪ Room design conditions of water temperature +2 K and 40-60% relative humidity; ▪ 100% outside air supply with ventilation heat recovery (sensible heat transfer effectiveness of 50%), and supply air heating only; ▪ Pool blanket is in use for all hours outside of normal operating hours; ▪ Use the same heating fuel source and equipment efficiency as for Domestic Hot Water; ▪ Water recirculation time of 6 hours for the total pool water volume. Circulation pump specific power of 0.17 kW/(L/s). Circulation of the pool water shall be continuous throughout the hours of operation; ▪ No underwater pool lighting; and ▪ Operation of backflushing cycle for a period of 10 minutes per filter cell once a week. Number of filter cells shall be the same as for the Proposed Project.

6.3 Operating Profiles

Default operating profiles for all project types are provided (refer to Section13.3). Modifications to suit project specific conditions are acceptable as follows:

- Changes of no more than 10% of equivalent full-load operating hours: all changes made for the purpose of the assessment must be declared in the project submission; or

- Changes of more than 10% of equivalent full-load operating hours: all changes requested for the purpose of the assessment must be submitted for approval as a technical question and must be accompanied by confirmation from the client that the changes made are in accordance with the anticipated project operation.

6.4 Modelling Daylight-Controlled Artificial Lighting Systems

Where credit is claimed for dimming control of artificial lighting in response to measured daylight in a space, other than by use of the deemed adjustment factors in Section 13.6.2, either of the following calculation methods may be applied:

- Calculation of hourly internal daylight levels by the project energy performance simulation software from first principles; or
- Calculation of daylight compensation by the project energy performance simulation software based on user-defined daylight factors and solar radiation from the weather data file.

Where points are claimed in theLight Quality Credit for the achievement of internal daylight levels, refer to Section 5.2 for details of required inputs to the project energy performance simulation model.

6.5 Modelling Control of Natural-Ventilation and Mixed-Mode Systems

The purpose of the inclusion of simulation control parameters for natural ventilation and mixed-mode systems is to provide consistency in simulations which could otherwise potentially produce widely varying results depending on the parameters applied, particularly where a system relies on occupant control. While there is no absolute correct specification of the control parameters, the following guidelines have been developed to be consistent with the holistic objectives of Green Star. Variation from these parameters, other than where specifically stated, is therefore not allowed.

For the following three systems, these controls are only required to be applied during the hours of project or plant operation, as specified in the operating schedules, not continuously.

6.5.1 Naturally-Ventilated Spaces with Heating Only

The project team shall assume the following control actuation:

- Minimum operable device opening factor: 10%
- Heating system operates when $T_{space} < T_{lower} + 0.5$;
- Operable devices open from minimum position when $T_{OA} > 12$ ℃;
- Operable devices are fully open when $T_{space} = 24$ ℃;
- Operable devices close to minimum position during any hour when the following conditions occur:
    - $T_{OA} > 35$ ℃;
    - $T_{OA} < T_{lower}$; or
    - $v_{wind} > 5$ m/s.

Where T_{space} is the space temperature (dry bulb, operative or other as applicable to the method of temperature control), T_{lower} is the lower limit of the space temperature control range, T_{OA} is the outdoor air dry bulb temperature (all °C), and v_{wind} is the external wind speed (m/s).

Note that this means that natural ventilation is the only means of ventilation. If operable devices are closed, no ventilation air enters the building.

6.5.2 Naturally-Ventilated Spaces with Heating and Cooling

Modelling shall be completed on the basis of agreed space temperature limits. Where the temperature control range is wider than the conventional range (21-24 °C), confirmation of client agreement of the temperature limits must be provided as part of the submission. The project team shall assume the following control actuation:

- Minimum operable device opening factor: 10%
- Heating system operates when $T_{space} < T_{lower} + 0.5$;
- Operable devices open from minimum position when $T_{OA} > 12$ °C;
- Operable devices are fully open when $T_{space} = T_{upper} - 1.0$;
- Mechanical cooling system operates when $T_{space} > T_{upper} - 0.5$.
- Operable devices close to minimum position during any hour when the following condition occurs:
  - $T_{OA} > 30$ °C;
  - $T_{OA} < T_{lower}$; or
  - $v_{wind} > 5$ m/s.

Where T_{space} is the space temperature (dry bulb, operative or other as applicable to the method of temperature control), T_{lower} and T_{upper} are the lower and upper limits of the space temperature control range respectively, T_{OA} is the outdoor air dry bulb temperature (all °C), and v_{wind} is the ambient wind speed (m/s).

Note that this means that natural ventilation is the only means of ventilation. When operable devices are closed, as under conditions of high/low external temperature or high wind, no ventilation air enters the building.

Note that this means that natural ventilation is the only means of ventilation. Operable devices will be open at all time during occupancy, including when cooling and heating systems are operational, and outside air load will contribute directly to the room heating or cooling load.

6.5.3 Mixed-Mode Spaces

Modelling shall be completed on the basis of agreed space temperature limits. Where the temperature control range is wider than the conventional range (21-24 °C), confirmation of client agreement of the temperature limits must be provided as part of the submission. The project team shall assume the following control actuation:

- Heating system operates when $T_{space} < T_{lower} + 0.5$;
- Heating system is deactivated and operable devices begin to open when $T_{space} = T_{lower} + 0.5$;
- Operable devices are fully open when $T_{space} = T_{upper} - 1.0$;
- Operable devices close when $T_{space} = T_{upper} - 0.5$; and
- Mechanical cooling system operates when $T_{space} > T_{upper} - 0.5$.

Where T_{space} is the space temperature (dry bulb, operative or other as applicable to the method of temperature control), and T_{lower} and T_{upper} are the lower and upper limits of the space temperature control range respectively (all °C).

If the project is implementing an alternative form of automatic control, an alternative simulation control methodology may be proposed by the project team. A technical question must be submitted prior to implementation in the model. Where system operation is dependent on occupant control of operable devices, the above criteria may not be modified under any circumstances.

Note that 'Mixed-Mode Spaces' means that natural ventilation only operates when space temperature is within the centre of the control range. When operable devices are closed, ventilation occurs via the mechanical/AC system.

6.6 Modelling Operation of Air Conditioning Systems

The air conditioning system component of the energy model must account for all of the following features of system operation, as relevant to the system and its control:

- Individual fans, fan duties (air flow and static pressure) and fan part-load performance characteristics (for variable-speed control systems);

- Economy cycle operation and control lockouts;
- Heat recovery system operation, control lockouts, ancillary components (i.e. pumps in run around coil systems and fan motors in rotary thermal wheel systems), and heat transfer effectiveness (sensible and latent components);
- Supply air temperature reset controls;
- Ductwork distribution system heat gains and losses;
- Minimum flow rate settings for variable volume systems;
- Independent specification of supply air and outdoor air flow rates;
- Humidity control, including dehumidification and humidification, as applicable;
- Evaporative cooling stages;
- Cycling of fan operation with temperature control systems in packaged air conditioning units.

6.7 Modelling Operation of Chilled Water Refrigeration Plant

The chilled water plant component of the energy model must account for all of the following features of plant operation, as relevant to the system design and its control:

- Individual chillers, chiller capacities, and chiller part-load performance characteristics, including effect of compressor part-load, ambient relief and chilled water leaving temperature set point;
- Hydraulic configuration of chillers, including parallel, series, sidecar and combinations of these;
- Interlocked operation of chilled water and condenser water pumps, and variable speed control of pumps;
- Operation of secondary pumps, including variable speed control and staged control of ganged pumps as applicable;
- Staging and sequencing control of chillers in response to cooling load or other system variable;
- Operation of oil sump heaters to maintain the oil temperature above a minimum threshold (where applicable);
- Chilled water set point temperature reset control;
- Distribution pipework thermal gains;
- Any additional cooling loads imposed on the chilled water system due to end uses other than space cooling, e.g. direct water cooling of process equipment;
- Heat rejection to individual or multiple heat rejection units, including staging control of heat rejection units;
- Condenser water temperature reset in response to ambient temperature and fan speed control in response to leaving water temperature;
- Cooling tower fan power and variable speed control of fans; and
- Staging and sequencing control of cooling towers in response to heat rejection load or other system variable.

Additionally, where the condenser water system is used to service heat rejection applications other than chilled water plant heat rejection, the following must be included, as relevant to the system design and control:

- Heat rejection from tenant supplementary heat rejection systems;
- Any additional cooling loads imposed on the condenser water system due to end uses other than space cooling, e.g. direct water cooling of process equipment; and
- Operation of condenser water pumps, and variable-speed control of pumps.

6.8 Modelling Operation of Space Heating Plant

The heating hot water plant component of the energy model must account for all of the following features of plant operation, as relevant to the system design and control:

- Individual equipment part-load performance characteristics;
- Hydraulic configuration of heaters, including parallel, series, sidecar and combinations of these;
- Interlocked operation with heating hot water pumps, and variable speed control of pumps;
- Operation of secondary pumps, including variable speed control and staged control of ganged pumps as applicable;
- Staging and sequencing control in response to heating load or other system variable;
- Heating hot water set point temperature reset control;
- Distribution pipework thermal losses;
- Distribution system thermal inertia (lag in the heating system due to the requirement to heat all pipework and water in the system from a low temperature to operating temperature on start up); and
- Any additional heating loads imposed on the heating hot water system due to end uses other than space heating, e.g. indirect heating of domestic hot water, direct water heating of process equipment.

6.9 Modelling Domestic Hot Water Systems

The Proposed and Reference Project domestic hot water system energy consumption shall be based on the total domestic hot water usage calculated by the Potable Water Calculator (refer to Section 5.5).

Where the Proposed Project features multiple independent systems, the Reference Project must include the same number of systems serving the same areas of the project. The total domestic hot water usage for the project, as determined by the Potable Water Calculator, must be apportioned to each of these systems. The project team must demonstrate how this has been calculated. This may be by consideration of the building area served by each system, the relative water usage for each end use in the project, by use of available reference or empirical data whether project specific or generic (e.g. the histograms in CIBSE, 2004), or any combination of these or other methods. Where the same system type serves more than one part of the project, they may be aggregated for calculation purposes.

Where the project team is of the opinion that hot water usage included in the Potable Water Calculator is outside of the scope of the applicable rating type, and should be excluded from the calculations, this should be addressed in a technical question.

Where a system is served from another thermal energy source, e.g. heating hot water system, a solar thermal collector requiring application of the detailed calculation method (refer to section 7.2) or recovered energy from another process, the annual total water usage for the system shall be converted to an hourly usage profile by consideration of:

- The number of days of project operation and the extent of operation per day (i.e. whether all or only a proportion of the end uses served by the system are operational); and
- The usage during each day of operation. This may be by consideration of the hours of operation of the project the relative water usage for each end use in the project and the times at which these are likely to occur, by use of available reference data whether project specific or generic (e.g. the histograms in CIBSE, 2004), or any combination of these.

Estimation of hourly usage profiles is necessary in these cases to ensure that consideration is given to the simultaneity of energy availability and energy demand, and the consequential impacts on overall energy utilisation and system efficiency and performance.

Calculations of energy consumption may generally be based on total annual delivery volume of domestic hot water, with due account made for system losses from tanks, pipework and other components as applicable. Where the project team chooses to apply loss factors for the Proposed Project that is less than the Reference Project values, these must be justified by the project team. Make up water temperature is the time-weighted average of the defined reference values. However, for indirect-fired systems as described above, calculations must be based on an hourly calculation of demand, losses and input. Such calculations must be completed as part of the overall energy simulation (as per Section 4.3) and it is expected that the software would facilitate the calculation of losses based on system physical characteristics (including storage tank geometry and insulation thickness, and distribution pipework system length, representative diameter, and insulation thickness) and environmental temperatures (which may be based on unconditioned space temperatures calculated in the thermal simulation model, for example); where this is the case, Proposed Project losses must be calculated in this way.

The general form of the annual energy calculation is:

$$Q_{input} = \frac{q_{DHW} c_p \Delta T}{1000 \eta_{heater}} \left(1 + f_{standing} + f_{distribution}\right)$$

Where Q_{input} is the system total annual energy consumption (MJ/annum), q_{DHW} is the system annual domestic hot water usage (L/annum), c_p is the specific heat capacity of water (approximately 4.19 kJ/kg.K), ΔT is the temperature difference between supply and make up water temperatures (K), η_{heater} is the gross thermal efficiency of the water heater (%), $f_{standing}$ is a factor accounting for standing losses in the system, and $f_{distribution}$ is a factor accounting for distribution losses in the system. The factor 1000 adjusts from kilojoules to megajoules. Note that for the purpose of this calculation it is assumed that 1 L of water has a mass of exactly 1 kg.

Energy consumption of circulation pumps and other ancillary system components must be included in the building total energy consumption for both the Proposed and Reference Projects. For the Reference Project, these values may be determined by prorating the Proposed Project values as follows:

$$X_{ref} = \frac{q_{ref}}{q_{prop}} X_{prop}$$

Where X is the quantity to be prorated, q is the annual domestic hot water usage (L/annum) for the system, and subscripts ref and prop refer to the Reference Project and Proposed Project values respectively.

6.10 Modelling Local Shared Services Utilities

Where the project energy is sourced from a local low carbon shared services utility, as one or more of electricity, chilled water, heating hot water or domestic hot water, the modelling shall be completed so as to determine the demand to be met at the point of interface with the utility service. Specific considerations that must be addressed in the model include:

- Hydraulic configuration of chilled water interface in chilled water system;
- Staging and sequencing of chilled water interface where other conventional chilled water equipment is also provided in the building for duty operation;
- Hydraulic configuration of heating hot water interface in heating hot water system; and
- Staging and sequencing of heating hot water interface where other conventional heating hot water equipment is also provided in the building for duty operation.

All loads shall be entered into the credit calculator as kWh values.

6.11 Modelling Water Usage of Evaporative Cooling Systems

Evaporative cooling (direct or indirect) system water consumption models must account for direct evaporation due to system cooling operation. Direct evaporation shall be based on latent heat of vaporisation of water of 2,450 kJ/kg.

In systems utilising variable-speed fan control, the effect of air speed on saturation efficiency of the evaporative media shall be considered (generally, the lower the air speed the higher the efficiency) (e.g. DOE, 2013).

6.12 Modelling Water Usage of Heat Rejection Systems

Water consumption due to conventional cooling towers is calculated in the Potable Water calculator based on the monthly total heat rejection load (refer to Section 5.5). The simulation is only required to calculate water usage of heat rejection systems where technology other than conventional cooling towers (e.g. adiabatic coolers) is used. The calculation must account for water usage due to:

- Direct evaporation due to system cooling operation;
- Drift loss due to carry over of atomised water droplets in the air stream; and
- Blowdown loss due to the purging of high-mineral concentration water from either the condenser water (if an open condenser water system) or from the dedicated recirculation cooling water (if a closed condenser water system).

Direct evaporation shall be based on latent heat of vaporisation of water of 2,450 kJ/kg.

If water softening equipment is used to reduce the hardness of water prior to supply to the heat rejection equipment, the energy consumption of this equipment must be included in the project total energy consumption.

7 RENEWABLE ENERGY SYSTEMS MODELLING GUIDELINES

7.1 Photovoltaic Systems

Where on-site photovoltaic (PV) systems are provided, the associated power and energy generation must be assessed based on the following methodology.

7.1.1 General Modelling Criteria

The calculation of the power and energy generation of the PV system must include allowance for all of the parameters described in Table 2: Photovoltaic system performance modelling requirements.

Table 2: Photovoltaic system performance modelling requirements

Item	Description	Requirement
1	Performance calculation method	Analysis software must satisfy the Green Star compliance framework. Refer to Section 7.1.2 for details.
2	Location (selection of climate file)	The analysis must use the same hourly weather dataset as used in the assessment of the HVAC system performance (refer to Section 6.2).
3	Adjacent structures and features	Existing adjacent buildings must be included in the model; refer to Section 6.2 (item 3) for details.
4	Environmental conditions	The analysis must use the same environmental conditions as used in the assessment of the HVAC system performance (refer to Section 6.2).
6	Geometric model	The representation of Proposed Project PV system geometry shall be consistent with the design documents, including: ▪ Number and position of PV modules; ▪ PV module tilt angle; ▪ PV module azimuth angle; and ▪ PV array shading from building features.
7	PV system losses	Derating factors must be included to account for loss of power generated by the PV system, as follows: ▪ Mismatch: 0.98 ▪ Diodes and connections: 0.995 ▪ DC wiring: 0.98

		▪ Array soiling: 0.95 ▪ Tracking losses: 0.95 (note 1) ▪ Inverter and transformer: 0.92 (note 2) ▪ AC wiring: 0.99 If non-standard factors are used the project team must justify assumptions with appropriate evidence.
8	Cell temperature losses	Derating factor must be included for increase of PV cell temperature, typically expressed as a loss coefficient or efficiency reduction based on PV cell temperature compared with the reference temperature (e.g. %/K difference from reference temperature).

Notes:

1: Only required to be included if an automatic solar tracking system (single-axis or dual-axis) is included.

2: Where a specific inverter type is nominated in the design documents, the efficiency curve for the actual inverter may be used in place of this default value.

7.1.2 Software Compliance Framework

The requirements for PV performance analysis software used to estimate the power and energy generation of the PV system are defined in Table 3. The modelling tool used by the project team must incorporate ALL of the features listed under Mandatory Requirements; the additional features listed in the right hand column are not mandatory but will contribute to more robust estimation of energy generation.

The following is a list of software programs that are deemed by the NZGBC to comply with the below requirements.

- System Advisory Model (SAM) (developed by the National Renewable Energy Laboratory, USA); and
- PVSyst (developed by PVSyst SA, Switzerland).

No supporting information needs to be provided to demonstrate compliance with the requirements where any of these programs are used by the project team. If a project team uses different software, they must demonstrate that the software is compliant with the framework in Table 3.

Table 3: Compliance framework for PV performance analysis software

Item	Mandatory Requirement	Additional Features
Climatic Data	Use hourly weather data for the applicable building location.	
User Defined Model	Allow the user to input the design PV module orientation; Allow the user to input the PV module efficiency for the design system; Allow the user to input the PV system losses as per the derating factors (either as individual values or one combined value); Allow the user to input the cell temperature losses as derating factors.	The modelling tool includes a database of tested product specific information which allows efficiency curves of PV modules and inverters to be applied and calculated hourly as part of the model simulation; System design details included within the model, e.g. number of strings.
Shading Analysis	The modelling tool used must satisfy one of the following conditions: ▪ The modelling tool incorporates an hourly shading analysis included as part of the model simulation. The	The modelling tool includes a self-shading calculation based on the configuration of the PV array. The modelling tool accounts for the effect of shading caused by obstacles

	tool may achieve this through creation of a 3D model of the array and shading elements, or, by assigning hourly shading derate factors for expected shading; or ▪ The modelling tool has a function to import results of a third-party hourly shading analysis.	sufficiently far for considering the sun over or under the horizon line at a given time, i.e. the beam component of solar irradiation is considered off for the shaded time. This could be either as part of the model simulation itself or as separate derate factors per azimuth by altitude.

7.1.3 Shading Analysis Requirements

Where there are shading elements which cause shadowing of the PV system, the resultant shading may have a significant impact on the potential for energy generation from the PV system. Consideration of these effects through appropriate shading analysis must be included as part of the performance analysis. This includes the effect of adjacent buildings (existing and proposed), landscape features, and any other permanent shading source. Projects claiming that there are no significant shading sources must clearly demonstrate that this is the case.

The project team must describe how the derating factor due to the shading source has been applied in the calculation, in particular how the effect of partial shading of a module on the output of the whole string has been factored into the assessment. The NZGBC has not yet finalised a standard methodology for calculating shading losses so it is up to the project team to propose a conservative methodology. As long as the proposed methodology provides a methodology for calculating the impact of the following issues, it will be accepted. Issues which must be considered when calculating shading losses:

- String length;
- Estimation of cell output loss in relation to amount of panel shaded; and
- The impact of the lowered output from one panel on the entire string.

Further, all projects shall consider the issue of self-shading which can occur at low sun-angles when PV modules may create a shadow on adjacent PV modules of the array. If self-shading is present, and unless it is demonstrated otherwise through a shading analysis, a default de-rating factor of 0.9 must be applied for the time during the year that self-shading occurs.

7.2 Solar Thermal Systems for Domestic Hot Water

Where solar domestic hot water systems are installed, their contribution to the domestic hot water demand shall be determined as follows:

- Calculate the monthly domestic hot water heating demand for the project, based on the daily water usage (from the Potable Water calculator), make up water temperature as per Table 1, system storage and flow temperatures as per the design, and estimated system heat losses;
- Calculate the useful monthly supply of hot water from the solar thermal system components using the methodology outlined in either UK SAP 10.2 or EN15316-4-3:2017 with monthly solar radiation and energy figures specific to the building location.
- The monthly energy saving is subtracted from the monthly heating demand to give the net energy input required by the system. This value is adjusted by the system heating efficiency as required to give the total energy input required by the system.

Where domestic hot water energy consumption is greater than 10% of in scope building energy consumption the analysis above must be undertaken on an hourly basis utilising solar radiation, and ambient temperature values from the hourly weather dataset.

7.3 Solar Thermal Systems for Space Heating or Solar Cooling

Where solar thermal systems are used for the generation of heating water to be used for space heating or space cooling applications (such as in conjunction with an absorption chiller), the analysis of the thermal output must be integrated with the main HVAC performance simulation, as per Section 6. The modelling algorithm for the solar thermal components must be based on the efficiency coefficients for the panel determined in accordance with the reference standard (SA, 2007 for glazed collectors and ISO, 1995 for unglazed collectors), and include hourly calculation of thermal output based on ambient temperature values from the hourly weather dataset.

Note that owing to the seasonal variation of heating and cooling load and solar availability, it is not acceptable to apply the simple methodology for domestic hot water systems under any circumstances.

7.4 Wind Turbines

Calculation of the energy generation of wind turbines must account for all of the following features of operation, as relevant to the system design and control:

- Cut in and cut out wind speeds (i.e. maximum and minimum wind speeds at which the generator can operate);
- Aerodynamic efficiency or power output as a function of wind speed;
- Consideration of the effect of the turbine location on the output including:
- Variation of the open field wind speed (as per the weather dataset) within the local urban environment, and variation of wind speed from the nominal value (as per the weather dataset) (typically measured at 10 m above ground level) to the actual installation height of the wind turbines. Correction shall be made in accordance with the methodology of BS, 1991 (Section 11.2, equation 5) or ASHRAE, 2013 (Chapter 24, equation 4);
- Variation of wind speed and vortex effects where multiple wind turbines are located in close proximity. Project teams shall to demonstrate that due consideration of these effects has been made in determining the energy generation from wind turbines. This may include the application of computational fluid dynamics (CFD) modelling or design advice from a wind engineering consultant. A technical question must be submitted to confirm the approach prior to implementation in the model.

8 EVALUATING ENERGY REDUCTION

Based on the completed project energy performance analysis, the energy consumption reduction are calculated by entering the Reference and Proposed Project annual energy consumption data into the Green Star Energy Use calculator. Values shall be entered for all end uses as applicable to the project. These values should represent the energy consumed by each end use, irrespective of the energy source; all offsets due to on-site generation and other such systems shall be treated as overall offsets on total site energy demand.

Energy use reduction is calculated based on comparison of the Reference Project and the Proposed Project. As per the definitions of these, all design variables are reflected in this comparison, including services design strategy.

The calculator includes other services, such as lighting and vertical transportation, which affect the results of the energy consumption. The rationale of including other non-HVAC components in the calculation are to encourage the most cost-efficient solution without prejudice to any specific part of the building, as compared to a purely HVAC energy-based calculation which will only emphasise a higher performing façade.

9 EVALUATING PEAK ELECTRICITY DEMAND REDUCTION

The primary intent of this credit is to reduce the impact on the electricity grid at peak demand times. This reduces the need for non-renewable generation to supplement renewables at peak times and reduces the demand for additional generation infrastructure. Therefore, points are awarded specifically for reducing demand during the times when the grid typically sees the highest demand, which may not align with the buildings peak demand. The buildings absolute peak demand must be demonstrated to not exceed the reference case to avoid increasing the demand on local infrastructure.

The grid tends to see highest demand during cold winter mornings and evenings, largely caused by residential heating and appliance use. Although this may not be directly caused by commercial buildings, any load added to the grid during these times will add to peak demand.

Three options are presented in the *Grid Resilience* credit to meet the demand reduction. Passive design solutions such as increased insulation to reduce heating demand may be used to achieve the 10% reduction required for Credit Achievement. To achieve Exceptional Performance, an additional 10% (20% total) must be achieved using Active Solutions, either Demand Response or Storage as described in the Submission Guidelines.

Demand Response may be achieved by actively turning off some loads during times of grid peak demand and shifting them towards times of lower demand.

Thermal storage (such as chilled water storage systems) or electricity storage (batteries) may be used to supply the building during times of peak demand, thereby reducing the demand from the grid. On site renewable generation may only be used to demonstrate peak demand reduction if it can be demonstrated to reliably generate during times of grid peak demand. Photovoltaic solar generation is therefore unlikely to be a feasible solution as it will not be available on winter mornings or evenings. Grid supplied electricity may be used to recharge storage systems during off-peak times.

A storage system must have the capacity to meet the reduction demand for at least a four-hour period (5-9pm) or the morning peak period (7-10am), whichever is greater.

Note that load shifting or recharging of storage systems may cause the demand to exceed that of a reference building temporarily, as long as it does not increase the absolute building peak demand.

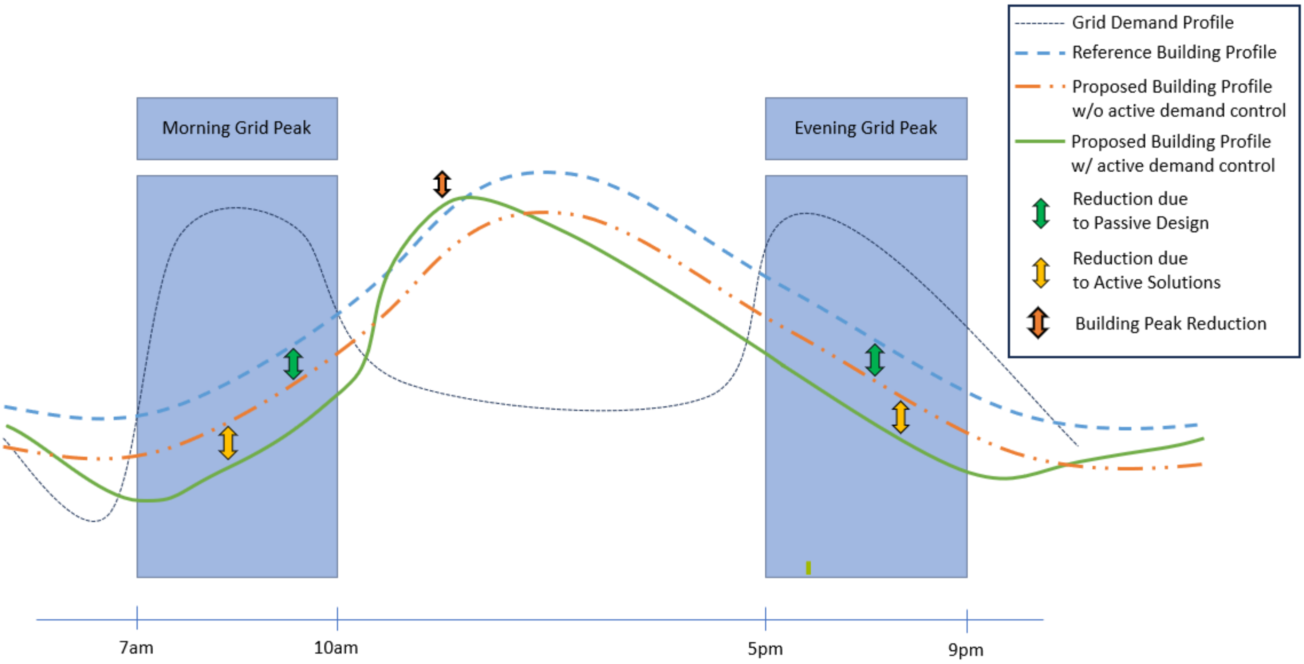

Figure 1: Peak Demand Profiles

Figure 1 is a visual representation of a hypothetical example showing the reduction profile used to achieve the Credit 20 requirements.

- The Grid Demand Profile represents the demand on the grid on a winter day, peaking in the morning and evening.
- The Proposed Building Profile without active demand control represents a reduction of at least 10% during the grid peak periods, compared to a reference building using passive design solutions, meeting the Credit Achievement.
- The Proposed Building Profile with active demand control represents a reduction of 20% during the grid peak periods, compared to a reference building using a combination of passive and active design solutions, meeting the Exceptional Performance. At least 10% of the reduction is achieved through active means. The demand temporarily exceeds that of the reference building (outside of the peak period) due to load shifting or the recharging of storage systems. The overall building peak of the reference building is not exceeded in the proposed building.

Based on the completed building energy performance analysis, the hourly electricity demand reduction is calculated by entering the Reference and Proposed Project hourly electricity demand data into the Green Star Energy Use calculator. The peak electricity demand is determined as follows:

- For the Proposed and Reference Project, identify the hourly value of building electrical demand;
- Provide evidence that for every hour during the grid peak periods the proposed buildings demand is less than that of the reference building.
- Demonstrate that the overall proposed building peak demand does not exceed that of the reference building.

10 ENERGY MODEL REPORT CONTENT

The following sections describe the scope of modelling inputs that shall be reported on. Tables may need to be replicated to describe each system in the project.

All details shall be supported by suitable evidence such as drawings, specifications, product selections, supplementary calculations or other evidence that the systems and performance levels utilised in the model are representative of the project.

Where simplifications have been undertaken, they shall be justified with a description of the approach taken and a discussion on the impacts of simplification, highlighting how this results in a conservative approach.

10.1 Analysis Software Description

Project teams must provide information on analysis software used.

Table 4: Energy simulation analysis software reporting requirements

Software name and version	
Software developer	
Software validation standard (evidence of developer's compliance to be provided)	
Simulator's name (include description of training and experience with software)	

10.2 Description

Project teams must confirm all project parameters as listed in Table 5.

Table 5: General parameters reporting requirements

	Proposed Project	Reference Project
Climate zone		
Weather data (location and data format)		
Number of building storeys (below ground/above ground)		
Total modelled building gross floor area (GFA) (m^2)		

10.3 Space Summary

Project teams must confirm project space types and associated parameters as listed in Table 6 and Table 7. Project teams may provide a set of drawing mark ups rather than a table summary if this is more convenient. Where operating profiles have been modified from the default values provided in Section 13.3, this should be noted and justification given in an accompanying document as per Section 6.3.

Table 6: Area summary reporting requirements

Space Type	Building Level	Gross Floor Area (m^2)		
		Conditioned	Unconditioned	Total

Table 7: Simulation input summary reporting requirements

Space Type	Operating Profile(s) Applied	Temperature Control Range (°C)	Occupancy Density (m^2/person)	Equipment Load (W/m^2)

10.4 Building Fabric Description

10.4.1 Opaque Fabric Components

Project teams must report all R Values for all wall and roof system types used in the building.

Table 8: Building opaque fabric parameters reporting requirements

Parameter	Proposed Project	Reference Project
External above-grade envelope wall construction and R value		
External below-grade envelope wall construction and R value		
Internal envelope wall construction and R value		
Roof construction, solar absorptance and R value		
Floor construction and R value		
Cool, cold or hot room construction and R value		

10.4.2 Transparent Fabric Components

Project teams must report all U Values and SHGC for glazing and rooflights/skylights as per table 9 below:

Table 9: Building glazing parameters reporting requirements

Parameter	Proposed Project	Reference Project
External Glazing U-Value and SHGC		
Rooflight/skylight U-Value and SHGC		

10.5 HVAC Services Description

10.5.1 Air Conditioning and Air Handling Systems

Project teams must provide details for each system present in the project.

Table 10: Air conditioning system parameters reporting requirements

Parameter	Proposed Project	Reference Project
Primary air conditioning system type		
Other air conditioning system type(s)		
Space served		
Design supply air temperature difference (K)		
Supply air temperature control		
Outdoor air design volume flow rate (L/s)		
Fan design supply air volume flow rate (L/s)		
Fan design absorbed power (kWe)		
Minimum flow rate turndown (%)		
Economy cycle control		
Demand-controlled ventilation		
Heat recovery type		
Heat recovery effectiveness		
Heat recovery parasitic power (kWe)		

Table 11: Ventilation system parameters reporting requirements

Parameter	Proposed Project	Reference Project
Ventilation system type		
Fan design supply air volume (L/s)		
Fan design absorbed power (kWe)		

10.5.2 Unitary Plant

Project teams must provide details for each system present in the project.

Table 12: Unitary plant parameters reporting requirements

Parameter	Proposed Project	Reference Project
Packaged equipment cooling performance (EER)		
Packaged equipment heating performance (COP)		

10.5.3 Cooling and Heat Rejection Plant

Project teams must provide details for each system and each individual item of equipment present. Note that chiller part-load performance should be stated in terms of net part-load value (NPLV, calculated at the design operating conditions), not integrated part-load value (IPLV, calculated at the reference operating conditions).

Table 13: Cooling and heat rejection plant parameters reporting requirements

Parameter	Proposed Project	Reference Project
Chiller type		
Chiller capacity (kWr)		
Design CHW flow temperature (°C)		
Design CHW temperature difference (K)		
Design CCW entering temperature (°C)		
Design CCW temperature difference (K)		
Chiller full-load performance (EER)		
Chiller part-load performance (NPLV)		
CHW temperature control		
Chiller sequencing and staging control		
System distribution losses (kW)		
Primary pump absorbed power (kWe)		
Primary pump control		
Primary pump minimum flow (if variable flow) (%)		
Secondary pump number and absorbed power (kWe)		
Secondary pump control		
CCW heat rejection type		
CCW heat rejection capacity (kW)		
Fan absorbed power (kWe)		
Leaving CCW temperature set point (°C)		
Fan speed control		
Heat rejection sequencing and staging control		
Heat rejection equipment drift loss (%)		
Heat rejection equipment cycles of concentration		

10.5.4 Heating Plant

Project teams must provide details for each system and each individual item of equipment present.

Table 14: Heating plant parameters reporting requirements

Parameter	Proposed Project	Reference Project
Heat source type		
Heat source capacity (kWr)		
Design HHW flow temperature (°C)		
Design HHW temperature difference (K)		
Heat source full-load performance (gross efficiency)		
HHW flow temperature control		
Heat source sequencing and staging control		
System distribution losses (kW)		
System thermal inertia (kW)		
Primary pump absorbed power (kWe)		
Secondary pump absorbed power (kWe)		
Primary pump control		
Secondary pump control		

10.6 Lighting Description

Project teams must provide description of each space usage for both internal and external lighting. Project teams must provide details for each system present in the project.

Table 16: Internal lighting parameters reporting requirements

Parameter	Proposed Project	Reference Project
Lighting type		
Design illuminance (lux)		
Nominal lighting power density (W/m²)		
Occupant sensor controls		NA
Daylight controls		NA
Other lighting controls		NA
Adjustment factor applied		NA
Modelled lighting power density (W/m²)		

Table 17: External lighting parameters reporting requirements

Parameter	Proposed Project	Reference Project
Lighting type		
Lighting category		
Category minimum illuminance (lux)		
Design illuminance (lux)		
Design lighting power density (W/m²)		
Modelled lighting power density (W/m²)		
Controls		

10.7 Domestic Hot Water Services Description

Project teams must provide details for each system present in the project. Hot water usage profiles must be documented where required to be used by Section 6.9.

Table 18: Domestic hot water services parameters reporting requirements

Parameter	Proposed Project	Reference Project
System type		
System heat source		
Solar thermal collector (Y/N)		
Hot water usage (L/annum)		
System storage capacity (L)		
Storage tank volume, each (L)		
Heater thermal efficiency (%)		
System supply water temperature (°C)		
System make up water temperature (°C)		
Recirculation pump (Y/N)		
Operating days (days/annum)		
No of connected outlets		
System standing loss factor		
System distribution loss factor		

10.8 Appliances Description

For residential (BCA Class 2) components of a *Green Star – Design & As Built* and *Green Star* – Interiors projects only, project teams must provide details of the appliances provided as part of the fitout.

Table 19: Appliance parameters reporting requirements

Parameter	Proposed Project	Reference Project
Refrigerator/freezer manufacturer and model		NA
Refrigerator/freezer energy consumption (kWh/annum)		
Dish washer manufacturer and model		NA
Dish washer energy consumption (kWh/annum)		
Clothes washer manufacturer and model		NA
Clothes washer energy consumption (kWh/annum)		
Clothes dryer manufacturer and model		NA
Clothes dryer energy consumption (kWh/annum)		

10.9 Swimming Pools Description

Project teams must provide details for each swimming pool present in the project. Hot water usage profiles must be documented where the system uses either indirect heating hot water and/or solar thermal heating

Table 20: Swimming pool parameters reporting requirements

Parameter	Proposed Project	Reference Project
Pool water volume (m³)		
Pool surface area (m²)		
Heat source		
Heater efficiency		
Circulation pump power (kW)		
Use of pool blanket		
Backflushing cycle duration		
Number of filters		
Design water temperature (°C)		
Room air design dry bulb temperature and relative humidity (°C/%)		

10.10 Process Loads Description

Project teams must provide details for each process present in the project. Project teams must provide evidence to justify the ratings and operation of both Proposed and Reference Project process loads, particularly where improvements are claimed.

Where a project team is able to demonstrate an improvement on a benchmark for a particular process load, the NZGBC will assess the proposed benchmarks on a case by case basis, through the technical question.

Parameter	Proposed Project	Reference Project
Process description		
Energy source		
Full-load power (kW)		
Equivalent full-load hours run		

10.11 Photovoltaic Analysis and System Description

Project teams must provide details for each system present in the project. Where an installation comprises of arrays having different inclinations and/or orientations, each array must be separately defined

Table 21: Photovoltaic analysis software reporting requirements

Software name and version	
Software developer	

If software other than that recognised by the NZGBC has been used, provide documentation demonstrating that it satisfies the compliance framework criteria.

Table 22: Photovoltaic array parameters reporting requirements

Parameter	Proposed Project
PV technology type	
PV module manufacturer and model	
PV rated output at STC (We)	
PV DC conversion efficiency at STC at full-load	
PV DC conversion efficiency at part-load	
Total PV array area (m²)	
Performance degradation	
PV array mounting system	
Inverter rating (kWe)	
Inverter efficiency at full-load and part-load	
System shading description	
PV array azimuth angle (°)	
PV array inclination angle (°)	
PV array losses	
PV cell temperature losses	

10.12 Solar Thermal System Description

Project teams must provide details for each system present in the project. Where an installation comprises of arrays having different inclinations and/or orientations, each array must be separately defined.

Table 23: Solar thermal array parameters reporting requirements

Parameter	Proposed Project
Solar collector type	
Collector absorber area (total) (m²)	
Collector efficiency coefficients (a_1 (-), a_2 (W/m² K) and a_3 (W/m² K²))	
Collector azimuth angle (°)	
Collector inclination angle (°)	
Circulation pump absorbed power (kWe)	
Preheat storage tank volume (L)	

10.13 Wind Turbine Description

Project teams must provide details for each system present in the project.

Table 24: Wind turbine parameters reporting requirements

Parameter	Proposed Project
Wind turbine type	
Wind turbine rated output (kWe)	
Wind turbine swept area (m^2)	
Wind turbine cut in wind speed (m/s)	
Wind turbine cut out wind speed (m/s)	
Wind turbine part-load aerodynamic efficiency	
Wind speed adjustments applied	
Wind turbine spacing (if more than one)	
Method of adjustment of turbine generated output for proximity effects of other wind turbines	

10.14 Manual Calculations

The project team shall provide a summary of all manual calculations used in the assessment of the project total energy consumption. This shall include a description of the methodology applied, comments on the limitations of the method, the data sources used in the calculation (including software outputs as applicable) and a summary of the calculation results.

10.15 Output Data

Project teams shall provide software output reports documenting the energy end uses applicable to each of the project models (i.e. Reference and Proposed). This information shall be readily reconcilable against the inputs in the Greenhouse Gas Emissions calculator. Where software output is supplemented with manual calculations, the manual calculation descriptions shall be cross referenced.

For shared utility services, the heating and cooling supplied to the project must be stated (as applicable). These, and the total electricity consumption, must be compared to the contractual agreements to demonstrate that they are within the specified limits. If no limits are specified, then it must be demonstrated that they are within the available output based on the details of the utility and any existing buildings' demands.

11 PEAK ELECTRICITY DEMAND REDUCTION REPORT CONTENT

Additional information shall be provided for this credit as follows:

- Hourly total electrical load profile for the Proposed Project and Reference Project. These are to be copied into the 'Grid Resilience' tab of the Energy Use Calculator.
- Evidence of controls systems used to decrease load during peak grid times.
- Hand calculations can be used to demonstrate storage system capacity is sufficient to reduce grid demand during grid peak times if this has not been included in the model.

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13 APPENDICES

13.1 HVAC System Design Parameters

For the purpose of sizing the HVAC systems in the Reference Project, the thermal loads shall be consistent with the design parameters applied for the Proposed Project system design, as per Table .

Table 25: HVAC system design parameters

Design Load Parameter	Proposed Project	Reference Project
Design weather conditions (summer dry bulb and wet bulb, and winter dry bulb temperatures; solar radiation)	As per design	As Proposed Project
Room design temperature and humidity (where applicable)	As per design	As Proposed Project
Room occupant density	As per design	As Proposed Project
Occupant heat gain (sensible and latent)	As per design	As Proposed Project
Equipment heat gain (sensible and latent)	As per design	As Proposed Project
Lighting heat gain	As per design	For each space type use lighting power density limits defined in NZS:4243.2 Table 1. For any space types not listed in NZS:4243.2 Table 1 use lighting power density calculation (NZS:4243.2 Section 3.4.9) with reference to AS/NZS 1680.2 maintained illuminance levels to determine lighting power density limit If the exact space type isn't listed in AS/NZS 1680.2, select most appropriate space type and associated maintained illuminance level. The same operating profiles must be used as are used in the Proposed Project (given in Section 13.3).
Outdoor air rate	As per design	NZBC minimum for each space type. Space Type refers to internal spaces intended for a different type of use. Spaces with different operational hours are considered different space types. If space type not covered under NZBC use the same outdoor air rate as in the Actual Building Model.
Building envelope	As per design	As per Section 6.2

Infiltration rate	As per air tightness testing results	As per Section 6.2

Notes:

1: For space types such as healthcare interventional suites, a Reference Project lighting power density of 25 W/m² shall be assumed.

13.2 HVAC System Simulation Parameters

The peak gain values that must be used for both the Proposed and Reference Project during the project simulation are as specified in this section, which, as specified in Section 6.2.

Table 26: HVAC simulation parameters

Item	Proposed Project	Reference Project
Temperature control band	For all air conditioned spaces, including process/manufacturing spaces and specialist labs such as clean rooms, the air conditioning must be modeled on the basis of the design temperature and humidity (where applicable) control ranges and achieve these for 98% of occupied hours. Where the design dry-bulb temperature range is outside 18-26°C, this may be used if: ▪ The design criteria for the project lists these space temperatures in the mechanical specifications for system sizing and selection; and ▪ The owner provides confirmation in a letter that the spaces will be operated under the design criteria provided; and that the thermostats will be programmed to these values; and ▪ Where an anchor tenant (at least 30% of NLA) has been confirmed for a speculative development, a letter from the tenant confirming their agreement for operating within this broader temperature band. When the credit Thermal Comfort is also claimed, the same temperature range must be used in evaluation of the PMV index.	Where spaces in the Proposed Project are air-conditioned, the Reference Project must achieve the same space temperature conditions as the Proposed Project for greater than 98% of occupied hours. Where spaces in the Proposed Project are provided with mechanical or natural ventilation systems to control overheating, the Reference Project may be modelled with air conditioning that achieves the same peak dry-bulb temperature condition. Where the Proposed Project uses radiant heating/cooling, natural ventilation or other systems that enable relaxed dry-bulb temperature requirements, the Reference Project may be modelled with tighter control bands, as long as both Reference and Proposed spaces achieve a PMV of between -1 and 1 for 98% of occupied hours across 95% of the floor area. The intent of this requirement is that the Reference Project generally achieves the same level of service as the Proposed Project. The Reference Project shall not achieve a higher level of comfort than the Proposed Project.
Maximum occupancy	The maximum occupancies that should be used in conjunction with the appropriate occupancy schedules, is the maximum design occupancy when known. Where it is not known, the occupancies given in NZS4303 or Appendix A of AS1668.2.2012 should be used. For supplementary air conditioning systems in Interiors projects, this should be modeled as the difference between the fit out and base building designs.	As Proposed Project.

Item	Proposed Project	Reference Project
Sensible and latent heat gain per person	The degree of activity within each space must be assessed by the design team and the appropriate sensible and latent gains used, and must be appropriate for the space design temperature. Acceptable sources of metabolic rates include AIRAH, 2013, ASHRAE, 2013 and CIBSE, 2006.	As Proposed Project.
Maximum lighting	The maximum lighting power density that should be used in conjunction with the lighting profile should be the adjusted lighting power density based on the Proposed Project lighting design and control (i.e. after the adjustment factors given in Section 13.6.2 have been applied). For supplementary lighting systems in Interiors projects, this should be modeled as the difference between the fit out and base building designs.	For each space type use lighting power density limits defined in NZS:4243.2 Table 1. For any space types not listed in NZS:4243.2 Table 1 use lighting power density calculation (NZS:4243.2 Section 3.4.9) with reference to AS/NZS 1680.2 maintained illuminance levels to determine lighting power density limit If the exact space type isn't listed in AS/NZS 1680.2, select most appropriate space type and associated maintained illuminance level.
Maximum equipment	The equipment loads that must be used in conjunction with the equipment profiles are given in the Default Operating Schedules. For supplementary air conditioning systems in Interiors projects, this should be modeled as the difference between the fit out and base building designs.	As Proposed Project.
Outdoor air rate	Outdoor air rates must be in accordance with the design. Outdoor air rates may be modulated if demand-controlled ventilation systems are specified; otherwise the design outdoor air rate must be simulated at all times during the projects operating hours.	NZBC minimum for each space type. Space Type refers to internal spaces intended for a different type of use. Spaces with different operational hours are considered different space types. If space type not covered under NZBC use the same outdoor air rate as in the Actual Building Model.

Notes:

1: Note that for healthcare interventional suites, a Reference Project lighting power density of 25 W/m² shall be assumed.

Table 27: HVAC system simulation equipment loads

Space Type (note 1)		Equipment load (W/m²)
Office		8
Industrial space	Where temperature control is localised and is not designed to handle equipment loads (e.g. manufacturing space)	0
	General industrial spaces (e.g. laboratory, workshop, warehouse)	15
	Where the HVAC system has been specifically designed to handle the equipment loads from a defined industrial process (e.g. clean room, server room, cold room)	Realistic operational loads must be estimated by the design team. The design loadings must not be used as these are intended to be maximum loads and not realistic operational loads. The methodology must be clearly documented.
Retail	Showroom (including in a building of another classification)	5
	Stores	40
	Mall, food court, public amenities	Realistic operational loads must be estimated by the design team. The design loadings must not be used as these are intended to be maximum loads and not realistic operational loads. The methodology must be clearly documented.
Fire Station		8 (office areas) 1 (all other areas)
Kitchen		200
Gymnasium (including any gymnasium space in a building of another classification)		15
Secondary spaces (e.g. circulation, corridors, stairways, store rooms, car parks)		0
Healthcare		Realistic operational loads must be estimated by the design team. The design loadings must not be used as these are intended to be maximum loads and not realistic operational loads. The methodology must be clearly documented.
Residential	Living Space	1100 W (sensible), 750 W (latent) (with kitchen) 0 (excluding kitchen)
	Bedrooms	0
School	Classroom, multi-purpose space, library	5
	Computer/science laboratory	27
	Canteen, workshop	25
University	Dry laboratories, specialist learning spaces, libraries	27
	Wet laboratories	40

Notes:

1: For any space types not referenced in this table, realistic operational loads must be estimated by the design team. The design loadings must not be used as these are intended to be maximum loads and not realistic operational loads. The methodology must be clearly documented.

13.3 Default Operating Schedules

This section contains the occupancy and operational profiles which must be applied to each zone within the project under assessment for calculation of the annual energy consumption.

In all cases, system operating hours are based on one hour of preconditioning occurring prior to the start of project occupancy. The modeller should verify that design temperatures are met at the start of project occupancy in both the Proposed and Reference Projects. Where this does not occur, the start time of system operation should be advanced until design temperatures are satisfied.

The equivalent full-load hours (per day type) are stated for all profiles, and should be used as the basis of evaluation of the variance noted in Section 6.3.

13.3.1 Office

Table 28: Office operating schedules

Hour of Day	Weekday			Saturday			Sunday		
	Occup	Lighting & Equip	HVAC	Occup	Lighting & Equip	HVAC	Occup	Lighting & Equip	HVAC
1	0%	5%	OFF	0%	5%	OFF	0%	5%	OFF
2	0%	5%	OFF	0%	5%	OFF	0%	5%	OFF
3	0%	5%	OFF	0%	5%	OFF	0%	5%	OFF
4	0%	5%	OFF	0%	5%	OFF	0%	5%	OFF
5	0%	5%	OFF	0%	5%	OFF	0%	5%	OFF
6	0%	5%	OFF	0%	5%	OFF	0%	5%	OFF
7	0%	5%	ON	0%	5%	OFF	0%	5%	OFF
8	95%	90%	ON	10%	30%	OFF	5%	5%	OFF
9	95%	90%	ON	10%	30%	ON	5%	5%	OFF
10	95%	90%	ON	10%	30%	ON	5%	5%	OFF
11	95%	90%	ON	5%	15%	ON	5%	5%	OFF
12	95%	90%	ON	5%	15%	OFF	5%	5%	OFF
13	95%	90%	ON	5%	15%	OFF	5%	5%	OFF
14	95%	90%	ON	5%	15%	OFF	5%	5%	OFF
15	95%	90%	ON	5%	15%	OFF	5%	5%	OFF
16	95%	90%	ON	5%	15%	OFF	5%	5%	OFF
17	95%	90%	ON	5%	15%	OFF	5%	5%	OFF
18	5%	30%	OFF	0%	5%	OFF	0%	5%	OFF
19	5%	30%	OFF	0%	5%	OFF	0%	5%	OFF
20	5%	30%	OFF	0%	5%	OFF	0%	5%	OFF
21	5%	30%	OFF	0%	5%	OFF	0%	5%	OFF
22	0%	5%	OFF	0%	5%	OFF	0%	5%	OFF
23	0%	5%	OFF	0%	5%	OFF	0%	5%	OFF
24	0%	5%	OFF	0%	5%	OFF	0%	5%	OFF
TOTAL	9.7	10.7	0	0.65	2.65	0	0.5	1.2	9.7

13.3.2 Healthcare General Areas (12 hours/day)

This profile is typical of the operation of a large number of small healthcare facility spaces. It may also be appropriate for a number of hospital spaces. This profile can be applied to spaces that operate for five or seven days of the week. Examples of space types which would use this profile for five days of the week include outpatients, waiting areas, consulting areas, diagnostic areas, medical records, pathology, pharmacy, auditoriums and seminar rooms. Examples of space types which would use this profile for seven days of the week include cafes and the hospital main receptions.

Table 29: Healthcare general areas (12 hours/day) operating profiles

Hour of Day	Weekday				Weekend (exc 7 day/week areas)			
	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%	15%	OFF	0%	10%	10%	OFF
8	15%	40%	25%	ON	0%	10%	10%	OFF
9	50%	80%	70%	ON	0%	10%	10%	OFF
10	70%	100%	100%	ON	0%	10%	10%	OFF
11	70%	100%	100%	ON	0%	10%	10%	OFF
12	70%	100%	100%	ON	0%	10%	10%	OFF
13	70%	100%	100%	ON	0%	10%	10%	OFF
14	70%	100%	100%	ON	0%	10%	10%	OFF
15	70%	100%	100%	ON	0%	10%	10%	OFF
16	70%	100%	100%	ON	0%	10%	10%	OFF
17	70%	100%	100%	ON	0%	10%	10%	OFF
18	50%	80%	60%	ON	0%	10%	10%	OFF
19	15%	60%	25%	ON	0%	10%	10%	OFF
20	5%	40%	15%	OFF	0%	10%	10%	OFF
21	5%	20%	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	7.0	12.2	11.15	12.0	0	2.4	2.4	0

13.3.3 Healthcare General Areas (24 hours/day)

Areas that are conditioned for 24 hours a day, seven days a week and that have peak operation for five days of the week and reduced operation over night and at the weekends. These profiles are typical of the operation of a large number of hospitals space types. They may also be appropriate for some spaces in smaller healthcare facilities. Examples of spaces that would use these profiles include medical imaging, recovery, central sterilising services department, pathology and pharmacy areas, within a hospital.

Table 30: Healthcare general areas (24 hours/day) operating profiles

Hour of Day	Weekday				Weekend (exc 7 day/week areas)			
	Occup	Lighting	Equip	HVAC	Occup	Lighting	Equip	HVAC
1	10%	25%	30%	ON	10%	25%	30%	ON
2	10%	25%	30%	ON	10%	25%	30%	ON
3	10%	25%	30%	ON	10%	25%	30%	ON
4	10%	25%	30%	ON	10%	25%	30%	ON
5	10%	25%	30%	ON	10%	25%	30%	ON
6	10%	25%	30%	ON	10%	25%	30%	ON
7	10%	25%	30%	ON	10%	25%	30%	ON
8	15%	40%	50%	ON	10%	25%	30%	ON
9	60%	80%	70%	ON	10%	25%	30%	ON
10	70%	100%	100%	ON	10%	25%	30%	ON
11	70%	100%	100%	ON	10%	25%	30%	ON
12	70%	100%	100%	ON	10%	25%	30%	ON
13	70%	100%	100%	ON	10%	25%	30%	ON
14	70%	100%	100%	ON	10%	25%	30%	ON
15	70%	100%	100%	ON	10%	25%	30%	ON
16	70%	100%	100%	ON	10%	25%	30%	ON
17	70%	100%	100%	ON	10%	25%	30%	ON
18	50%	80%	60%	ON	10%	25%	30%	ON
19	15%	60%	30%	ON	10%	25%	30%	ON
20	10%	40%	30%	ON	10%	25%	30%	ON
21	10%	25%	30%	ON	10%	25%	30%	ON
22	10%	25%	30%	ON	10%	25%	30%	ON
23	10%	25%	30%	ON	10%	25%	30%	ON
24	10%	25%	30%	ON	10%	25%	30%	ON
TOTAL	8.2	12.75	13.7	24	2.4	6.0	7.2	24

13.3.4 Healthcare Interventional Suite (12 hours/day)

Operating suite areas that will predominantly operate five days per week (Mon-Fri) for 12 hours per day. While it might be expected that the operating suite may be used on weekends, this is not its expected primary use pattern. Examples of spaces that would use this profile include general and endoscopy operating suite areas.

Table 31: Healthcare interventional suite (12 hours/day) operating profiles

Hour of Day	Weekday				Weekend			
	Occup	Lighting	Equip	HVAC	Occup	Lighting	Equip	HVAC
1	0%	15%	15%	ON	0%	15%	30%	ON
2	0%	15%	15%	ON	0%	15%	30%	ON
3	0%	15%	15%	ON	0%	15%	30%	ON
4	0%	15%	15%	ON	0%	15%	30%	ON
5	0%	15%	15%	ON	0%	15%	30%	ON
6	0%	15%	15%	ON	0%	15%	30%	ON
7	30%	50%	50%	ON	0%	15%	30%	ON
8	30%	50%	50%	ON	0%	15%	30%	ON
9	50%	80%	80%	ON	0%	15%	30%	ON
10	60%	90%	90%	ON	30%	50%	50%	ON
11	70%	90%	90%	ON	30%	50%	50%	ON
12	70%	90%	90%	ON	30%	50%	50%	ON
13	70%	90%	90%	ON	30%	50%	50%	ON
14	70%	90%	90%	ON	30%	50%	50%	ON
15	70%	90%	90%	ON	30%	50%	50%	ON
16	60%	90%	90%	ON	0%	15%	30%	ON
17	50%	80%	80%	ON	0%	15%	30%	ON
18	30%	50%	50%	ON	0%	15%	30%	ON
19	0%	15%	15%	ON	0%	15%	30%	ON
20	0%	15%	15%	ON	0%	15%	30%	ON
21	0%	15%	15%	ON	0%	15%	30%	ON
22	0%	15%	15%	ON	0%	15%	30%	ON
23	0%	15%	15%	ON	0%	15%	30%	ON
24	0%	15%	15%	ON	0%	15%	30%	ON
TOTAL	6.6	11.2	11.2	24	1.8	5.7	8.4	24

13.3.5 Healthcare Interventional Suite – 24 hours/day

This profile should be used for interventional suites that are intended to be in operation for 24 hours per day, seven days per week. A typical area that would use this profile is an operating suite in the emergency department of a hospital.

Table 32: Healthcare interventional suite (24 hours/day) operating profiles

Hour of Day	All Days			
	Occup	Lighting	Equip	HVAC
1	15%	25%	30%	ON
2	15%	25%	30%	ON
3	15%	25%	30%	ON
4	15%	25%	30%	ON
5	15%	25%	30%	ON
6	20%	30%	40%	ON
7	25%	40%	45%	ON
8	30%	50%	50%	ON
9	50%	80%	80%	ON
10	60%	90%	90%	ON
11	70%	90%	90%	ON
12	70%	90%	90%	ON
13	70%	90%	90%	ON
14	70%	90%	90%	ON
15	70%	90%	90%	ON
16	60%	90%	90%	ON
17	50%	80%	80%	ON
18	30%	50%	50%	ON
19	25%	40%	45%	ON
20	20%	30%	40%	ON
21	15%	25%	30%	ON
22	15%	25%	30%	ON
23	15%	25%	30%	ON
24	15%	25%	30%	ON
TOTAL	8.55	12.55	13.3	24

13.3.6 Healthcare Emergency Department

This profile should be used for all emergency department areas (except for the emergency interventional suites, which should use the Interventional Suite – 24 hour profile). All emergency areas are assumed to be conditioned for 24 hours per day, seven days per week. Two profiles are provided; one that should be used for the off-peak period between Sunday and Thursday and the other that should be used for the peak period of Friday and Saturday.

Table 33: Healthcare emergency department operating profiles

Hour of Day	Sunday-Thursday				Friday-Saturday			
	Occup	Lighting	Equip	HVAC	Occup	Lighting	Equip	HVAC
1	10%	100%	50%	ON	10%	100%	50%	ON
2	10%	100%	50%	ON	10%	100%	50%	ON
3	10%	100%	50%	ON	10%	100%	50%	ON
4	10%	100%	50%	ON	10%	100%	50%	ON
5	10%	100%	50%	ON	10%	100%	50%	ON
6	10%	100%	50%	ON	10%	100%	50%	ON
7	10%	100%	50%	ON	10%	100%	50%	ON
8	20%	100%	55%	ON	20%	100%	55%	ON
9	30%	100%	60%	ON	30%	100%	60%	ON
10	40%	100%	70%	ON	40%	100%	75%	ON
11	50%	100%	80%	ON	50%	100%	80%	ON
12	50%	100%	80%	ON	60%	100%	80%	ON
13	50%	100%	80%	ON	60%	100%	80%	ON
14	50%	100%	80%	ON	60%	100%	80%	ON
15	50%	100%	80%	ON	60%	100%	80%	ON
16	50%	100%	80%	ON	60%	100%	80%	ON
17	40%	100%	70%	ON	70%	100%	85%	ON
18	30%	100%	60%	ON	80%	100%	90%	ON
19	20%	100%	55%	ON	90%	100%	95%	ON
20	10%	100%	50%	ON	100%	100%	100%	ON
21	10%	100%	50%	ON	100%	100%	100%	ON
22	10%	100%	50%	ON	100%	100%	100%	ON
23	10%	100%	50%	ON	100%	100%	100%	ON
24	10%	100%	50%	ON	100%	100%	100%	ON
TOTAL	6.0	24	14.5	24	12.5	24	17.9	24

13.3.7 Healthcare Inpatient Units

All areas that are for the care and recovery of patients (in beds) which are occupied 24 hours per day, seven days per week. Areas that are expected to use this profile are all inpatient wards, maternity wards and critical care areas. It should also be used for the ward offices and nurse's stations.

Table 34: Healthcare inpatient unit operating profiles

Hour of Day	All Days			
	Occup	Lighting	Equip	HVAC
1	50%	10%	70%	ON
2	50%	10%	70%	ON
3	50%	10%	70%	ON
4	50%	10%	70%	ON
5	50%	10%	70%	ON
6	50%	25%	70%	ON
7	50%	25%	70%	ON
8	60%	80%	70%	ON
9	60%	100%	70%	ON
10	70%	100%	70%	ON
11	70%	100%	70%	ON
12	70%	100%	70%	ON
13	70%	100%	70%	ON
14	70%	100%	70%	ON
15	70%	100%	70%	ON
16	70%	100%	70%	ON
17	70%	100%	70%	ON
18	60%	80%	70%	ON
19	60%	25%	70%	ON
20	50%	25%	70%	ON
21	50%	25%	70%	ON
22	50%	10%	70%	ON
23	50%	10%	70%	ON
24	50%	10%	70%	ON
TOTAL	14.0	12.65	16.8	24

13.3.8 Kitchens

This profile should be used for large kitchens for full catering operations. The profile assumes 16-hour operation, seven days per week.

Table 35: Kitchen operating profiles

Hour of Day	All Days			
	Occup	Lightin g	Equip	HVAC
1	0%	10%	10%	OFF
2	0%	10%	10%	OFF
3	0%	10%	10%	OFF
4	0%	10%	10%	OFF
5	0%	10%	10%	OFF
6	70%	100%	100%	ON
7	70%	100%	100%	ON
8	70%	100%	100%	ON
9	50%	100%	50%	ON
10	50%	100%	50%	ON
11	70%	100%	100%	ON
12	70%	100%	100%	ON
13	70%	100%	100%	ON
14	50%	100%	50%	ON
15	50%	100%	50%	ON
16	70%	100%	100%	ON
17	70%	100%	100%	ON
18	60%	100%	100%	ON
19	50%	100%	50%	ON
20	50%	100%	50%	ON
21	50%	100%	50%	ON
22	0%	10%	10%	OFF
23	0%	10%	10%	OFF
24	0%	10%	10%	OFF
TOTAL	9.7	16.8	13.3	16

13.3.9 Circulation (12 hours/day)

This profile should be used for all spaces that are lit and have low-level transient occupancy during the day only. This profile is expected to be used for corridors and stairways within facilities or departments with daytime operation only. Note that waiting areas are not considered transitory spaces.

Table 36: Circulation (12 hours/day) profiles

Hour of Day	Weekday				Weekend			
	Occup	Lighting	Equip	HVAC	Occup	Lighting	Equip	HVAC
1	0%	10%	0%	OFF	0%	10%	0%	OFF
2	0%	10%	0%	OFF	0%	10%	0%	OFF
3	0%	10%	0%	OFF	0%	10%	0%	OFF
4	0%	10%	0%	OFF	0%	10%	0%	OFF
5	0%	10%	0%	OFF	0%	10%	0%	OFF
6	0%	10%	0%	OFF	0%	10%	0%	OFF
7	0%	10%	0%	OFF	0%	10%	0%	OFF
8	0%	40%	0%	ON	0%	10%	0%	OFF
9	0%	80%	0%	ON	0%	10%	0%	OFF
10	0%	100%	0%	ON	0%	10%	0%	OFF
11	0%	100%	0%	ON	0%	10%	0%	OFF
12	0%	100%	0%	ON	0%	10%	0%	OFF
13	0%	100%	0%	ON	0%	10%	0%	OFF
14	0%	100%	0%	ON	0%	10%	0%	OFF
15	0%	100%	0%	ON	0%	10%	0%	OFF
16	0%	100%	0%	ON	0%	10%	0%	OFF
17	0%	100%	0%	ON	0%	10%	0%	OFF
18	0%	80%	0%	ON	0%	10%	0%	OFF
19	0%	60%	0%	ON	0%	10%	0%	OFF
20	0%	40%	0%	OFF	0%	10%	0%	OFF
21	0%	20%	0%	OFF	0%	10%	0%	OFF
22	0%	10%	0%	OFF	0%	10%	0%	OFF
23	0%	10%	0%	OFF	0%	10%	0%	OFF
24	0%	10%	0%	OFF	0%	10%	0%	OFF
TOTAL	0	12.2	0	12	0	2.4	0	0

13.3.10 Circulation (24 hours/day)

This profile should be used for all spaces that are lit and have low-level transient occupancy 24 hours per day, 7 days per week. This profile is expected to be used for corridors and stairways within facilities or departments with 24-hour operation. Note that waiting areas are not considered transitory spaces.

Table 37: circulation (24 hours/day) profiles

Hour of Day	All Days			
	Occup	Lighting	Equip	HVAC
1	0%	100%	0%	ON
2	0%	100%	0%	ON
3	0%	100%	0%	ON
4	0%	100%	0%	ON
5	0%	100%	0%	ON
6	0%	100%	0%	ON
7	0%	100%	0%	ON
8	0%	100%	0%	ON
9	0%	100%	0%	ON
10	0%	100%	0%	ON
11	0%	100%	0%	ON
12	0%	100%	0%	ON
13	0%	100%	0%	ON
14	0%	100%	0%	ON
15	0%	100%	0%	ON
16	0%	100%	0%	ON
17	0%	100%	0%	ON
18	0%	100%	0%	ON
19	0%	100%	0%	ON
20	0%	100%	0%	ON
21	0%	100%	0%	ON
22	0%	100%	0%	ON
23	0%	100%	0%	ON
24	0%	100%	0%	ON
TOTAL	0	24.0	0	24

13.3.11 Back of House

This profile should be used for back of house spaces which have very low transient occupancy and that are only lit during those periods of occupancy. Examples of areas that would use this profile are engineering or maintenance services, mechanical services and materials management areas. The HVAC section of this profile only applies to those back of house spaces which are conditioned; for all other areas, this should be taken as OFF. Regardless of the conditioning of the space, lighting is to be modelled as per this profile.

Table 38: Back of house operational profiles

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

13.3.12 School Classroom and Multipurpose Spaces

This profile should be used for all teaching spaces, including computer and science laboratories, manual workshops, and libraries. This profile should also be used for common spaces and gymnasia, except that the equipment load will be 0% at all times.

Table 39: School classroom or multipurpose space operational profiles

Hour of Day	Weekday				Weekend			
	Occup	Lighting	Equip	HVAC	Occup	Lighting	Equip	HVAC
1	0%	5%	5%	OFF	0%	10%	10%	OFF
2	0%	5%	5%	OFF	0%	10%	10%	OFF
3	0%	5%	5%	OFF	0%	10%	10%	OFF
4	0%	5%	5%	OFF	0%	10%	10%	OFF
5	0%	5%	5%	OFF	0%	10%	10%	OFF
6	0%	5%	5%	OFF	0%	10%	10%	OFF
7	0%	30%	85%	OFF	0%	10%	10%	OFF
8	15%	30%	85%	ON	0%	10%	10%	OFF
9	15%	100%	100%	ON	0%	10%	10%	OFF
10	100%	100%	100%	ON	0%	10%	10%	OFF
11	100%	100%	100%	ON	0%	10%	10%	OFF
12	100%	50%	70%	ON	0%	10%	10%	OFF
13	50%	100%	100%	ON	0%	10%	10%	OFF
14	100%	100%	100%	ON	0%	10%	10%	OFF
15	100%	100%	100%	ON	0%	10%	10%	OFF
16	100%	100%	100%	ON	0%	10%	10%	OFF
17	100%	30%	30%	ON	0%	10%	10%	OFF
18	15%	30%	30%	OFF	0%	10%	10%	OFF
19	15%	5%	5%	OFF	0%	10%	10%	OFF
20	0%	5%	5%	OFF	0%	10%	10%	OFF
21	0%	5%	5%	OFF	0%	10%	10%	OFF
22	0%	5%	5%	OFF	0%	10%	10%	OFF
23	0%	5%	5%	OFF	0%	10%	10%	OFF
24	0%	5%	5%	OFF	0%	10%	10%	OFF
TOTAL	8.1	9.3	10.6	10	0	2.4	2.4	0

13.3.13 School Canteen

Table 40: School canteen operational profiles

Hour of Day	Weekday				Weekend			
	Occup	Lighting	Equip	HVAC	Occup	Lighting	Equip	HVAC
1	0%	0%	10%	OFF	0%	0%	10%	OFF
2	0%	0%	10%	OFF	0%	0%	10%	OFF
3	0%	0%	10%	OFF	0%	0%	10%	OFF
4	0%	0%	10%	OFF	0%	0%	10%	OFF
5	0%	0%	10%	OFF	0%	0%	10%	OFF
6	0%	0%	10%	OFF	0%	0%	10%	OFF
7	0%	0%	10%	OFF	0%	0%	10%	OFF
8	0%	0%	10%	OFF	0%	0%	10%	OFF
9	0%	0%	10%	OFF	0%	0%	10%	OFF
10	0%	0%	10%	ON	0%	0%	10%	OFF
11	50%	100%	50%	ON	0%	0%	10%	OFF
12	100%	100%	100%	ON	0%	0%	10%	OFF
13	100%	100%	100%	ON	0%	0%	10%	OFF
14	100%	100%	100%	ON	0%	0%	10%	OFF
15	100%	100%	100%	ON	0%	0%	10%	OFF
16	0%	0%	10%	ON	0%	0%	10%	OFF
17	0%	0%	10%	OFF	0%	0%	10%	OFF
18	0%	0%	10%	OFF	0%	0%	10%	OFF
19	0%	0%	10%	OFF	0%	0%	10%	OFF
20	0%	0%	10%	OFF	0%	0%	10%	OFF
21	0%	0%	10%	OFF	0%	0%	10%	OFF
22	0%	0%	10%	OFF	0%	0%	10%	OFF
23	0%	0%	10%	OFF	0%	0%	10%	OFF
24	0%	0%	10%	OFF	0%	0%	10%	OFF
TOTAL	4.5	5.0	6.5	7.0	0	0	2.4	0

13.3.14 University Teaching and Classroom Spaces

Table 41: University teaching and classroom space operational profiles

Hour of Day	Weekday				Weekend			
	Occup	Lighting	Equip	HVAC	Occup	Lighting	Equip	HVAC
1	0%	5%	0%	OFF	0%	5%	0%	OFF
2	0%	5%	0%	OFF	0%	5%	0%	OFF
3	0%	5%	0%	OFF	0%	5%	0%	OFF
4	0%	5%	0%	OFF	0%	5%	0%	OFF
5	0%	5%	0%	OFF	0%	5%	0%	OFF
6	0%	5%	0%	OFF	0%	5%	0%	OFF
7	0%	5%	0%	OFF	0%	5%	0%	OFF
8	50%	50%	0%	ON	0%	5%	0%	OFF
9	50%	100%	0%	ON	0%	5%	0%	OFF
10	100%	100%	0%	ON	0%	5%	0%	OFF
11	100%	100%	0%	ON	0%	5%	0%	OFF
12	100%	80%	0%	ON	0%	5%	0%	OFF
13	50%	100%	0%	ON	0%	5%	0%	OFF
14	100%	100%	0%	ON	0%	5%	0%	OFF
15	100%	100%	0%	ON	0%	5%	0%	OFF
16	100%	100%	0%	ON	0%	5%	0%	OFF
17	100%	100%	0%	ON	0%	5%	0%	OFF
18	20%	20%	0%	OFF	0%	5%	0%	OFF
19	20%	20%	0%	OFF	0%	5%	0%	OFF
20	20%	20%	0%	OFF	0%	5%	0%	OFF
21	5%	5%	0%	OFF	0%	5%	0%	OFF
22	5%	5%	0%	OFF	0%	5%	0%	OFF
23	5%	5%	0%	OFF	0%	5%	0%	OFF
24	5%	5%	0%	OFF	0%	5%	0%	OFF
TOTAL	9.3	10.45	0	10	0	1.2	0	0

13.3.15 University Dry Laboratories, Speciality Learning Spaces and Libraries

Table 42: University dry laboratory, speciality learning space and library operational profiles

Hour of Day	Weekday				Weekend			
	Occup	Lighting	Equip	HVAC	Occup	Lighting	Equip	HVAC
1	0%	5%	5%	OFF	0%	5%	5%	OFF
2	0%	5%	5%	OFF	0%	5%	5%	OFF
3	0%	5%	5%	OFF	0%	5%	5%	OFF
4	0%	5%	5%	OFF	0%	5%	5%	OFF
5	0%	5%	5%	OFF	0%	5%	5%	OFF
6	0%	5%	5%	OFF	0%	5%	5%	OFF
7	0%	5%	5%	OFF	0%	5%	5%	OFF
8	50%	50%	50%	ON	0%	5%	5%	OFF
9	50%	50%	50%	ON	0%	5%	5%	OFF
10	100%	100%	100%	ON	0%	5%	5%	OFF
11	100%	100%	100%	ON	0%	5%	5%	OFF
12	100%	100%	100%	ON	0%	5%	5%	OFF
13	50%	80%	70%	ON	0%	5%	5%	OFF
14	100%	100%	100%	ON	0%	5%	5%	OFF
15	100%	100%	100%	ON	0%	5%	5%	OFF
16	100%	100%	100%	ON	0%	5%	5%	OFF
17	100%	100%	100%	ON	0%	5%	5%	OFF
18	20%	20%	20%	OFF	0%	5%	5%	OFF
19	20%	20%	20%	OFF	0%	5%	5%	OFF
20	20%	20%	20%	OFF	0%	5%	5%	OFF
21	0%	5%	5%	OFF	0%	5%	5%	OFF
22	0%	5%	5%	OFF	0%	5%	5%	OFF
23	0%	5%	5%	OFF	0%	5%	5%	OFF
24	0%	5%	5%	OFF	0%	5%	5%	OFF
TOTAL	9.1	9.95	9.85	10	0	1.2	1.2	0

13.3.15.1 University Common Spaces

Table 43: University common space operational profiles

Hour of Day	Weekday				Weekend			
	Occup	Lightin g	Equip	HVAC	Occup	Lightin g	Equip	HVAC
1	0%	5%	0%	OFF	0%	5%	5%	OFF
2	0%	5%	0%	OFF	0%	5%	5%	OFF
3	0%	5%	0%	OFF	0%	5%	5%	OFF
4	0%	5%	0%	OFF	0%	5%	5%	OFF
5	0%	5%	0%	OFF	0%	5%	5%	OFF
6	0%	5%	0%	OFF	0%	5%	5%	OFF
7	0%	5%	0%	OFF	0%	5%	5%	OFF
8	5%	30%	0%	ON	0%	5%	5%	OFF
9	15%	30%	0%	ON	0%	5%	5%	OFF
10	100%	100%	0%	ON	0%	5%	5%	OFF
11	100%	100%	0%	ON	0%	5%	5%	OFF
12	100%	100%	0%	ON	0%	5%	5%	OFF
13	50%	80%	0%	ON	0%	5%	5%	OFF
14	100%	100%	0%	ON	0%	5%	5%	OFF
15	100%	100%	0%	ON	0%	5%	5%	OFF
16	100%	100%	0%	ON	0%	5%	5%	OFF
17	100%	100%	0%	ON	0%	5%	5%	OFF
18	20%	30%	0%	OFF	0%	5%	5%	OFF
19	5%	30%	0%	OFF	0%	5%	5%	OFF
20	0%	5%	0%	OFF	0%	5%	5%	OFF
21	0%	5%	0%	OFF	0%	5%	5%	OFF
22	0%	5%	0%	OFF	0%	5%	5%	OFF
23	0%	5%	0%	OFF	0%	5%	5%	OFF
24	0%	5%	0%	OFF	0%	5%	5%	OFF
TOTAL	7.95	9.6	0	10	0	1.2	1.2	0

13.3.16 University Wet Laboratories

Table 44: University wet laboratory operational profiles

Hour of Day	Weekday				Weekend			
	Occup	Lighting	Equip	HVAC	Occup	Lighting	Equip	HVAC
1	0%	15%	5%	OFF	0%	15%	5%	OFF
2	0%	15%	5%	OFF	0%	15%	5%	OFF
3	0%	15%	5%	OFF	0%	15%	5%	OFF
4	0%	15%	5%	OFF	0%	15%	5%	OFF
5	0%	15%	5%	OFF	0%	15%	5%	OFF
6	0%	15%	5%	OFF	0%	15%	5%	OFF
7	15%	15%	25%	OFF	0%	15%	5%	OFF
8	15%	15%	25%	ON	0%	15%	5%	OFF
9	100%	100%	100%	ON	0%	15%	5%	OFF
10	100%	100%	100%	ON	0%	15%	5%	OFF
11	100%	100%	100%	ON	0%	15%	5%	OFF
12	100%	100%	100%	ON	0%	15%	5%	OFF
13	50%	80%	70%	ON	0%	15%	5%	OFF
14	100%	100%	100%	ON	0%	15%	5%	OFF
15	100%	100%	100%	ON	0%	15%	5%	OFF
16	100%	100%	100%	ON	0%	15%	5%	OFF
17	100%	100%	100%	ON	0%	15%	5%	OFF
18	100%	100%	100%	OFF	0%	15%	5%	OFF
19	35%	50%	40%	OFF	0%	15%	5%	OFF
20	35%	50%	40%	OFF	0%	15%	5%	OFF
21	35%	50%	40%	OFF	0%	15%	5%	OFF
22	35%	50%	40%	OFF	0%	15%	5%	OFF
23	0%	15%	5%	OFF	0%	15%	5%	OFF
24	0%	15%	5%	OFF	0%	15%	5%	OFF
TOTAL	11.2	11.3	12.2	10	0	3.6	1.2	0

13.3.17 University Gymnasia

Table 45: University gymnasium operational profiles

Hour of Day	Weekday				Weekend			
	Occup	Lightin g	Equip	HVAC	Occup	Lightin g	Equip	HVAC
1	0%	5%	5%	OFF	0%	5%	5%	OFF
2	0%	5%	5%	OFF	0%	5%	5%	OFF
3	0%	5%	5%	OFF	0%	5%	5%	OFF
4	0%	5%	5%	OFF	0%	5%	5%	OFF
5	0%	5%	5%	OFF	0%	5%	5%	OFF
6	0%	5%	5%	OFF	0%	5%	5%	OFF
7	80%	100%	80%	ON	0%	5%	5%	OFF
8	80%	100%	80%	ON	0%	5%	5%	OFF
9	80%	100%	80%	ON	0%	5%	5%	OFF
10	25%	100%	25%	ON	0%	5%	5%	OFF
11	25%	100%	25%	ON	0%	5%	5%	OFF
12	25%	100%	25%	ON	0%	5%	5%	OFF
13	100%	100%	100%	ON	0%	5%	5%	OFF
14	100%	100%	100%	ON	0%	5%	5%	OFF
15	25%	100%	25%	ON	0%	5%	5%	OFF
16	25%	100%	25%	ON	0%	5%	5%	OFF
17	25%	100%	25%	ON	0%	5%	5%	OFF
18	80%	100%	80%	ON	0%	5%	5%	OFF
19	80%	100%	80%	ON	0%	5%	5%	OFF
20	80%	100%	80%	ON	0%	5%	5%	OFF
21	35%	100%	35%	ON	0%	5%	5%	OFF
22	35%	100%	35%	ON	0%	5%	5%	OFF
23	0%	5%	5%	OFF	0%	5%	5%	OFF
24	0%	5%	5%	OFF	0%	5%	5%	OFF
TOTAL	9.0	16.4	9.4	16	0	1.2	1.2	0

13.3.18 Working Spaces (1 shift/day)

This profile should be used for workshops, galleries, function spaces, libraries, classrooms, laboratories, clean rooms and any other space that will be occupied during normal business hours only. This profile is based on 5 day per week operation; if the space is in use for longer, the profile should be adjusted accordingly.

Table 46: Working space (1 shift/day) operational profiles

Hour of Day	Weekday				Weekend			
	Occup	Lighting	Equip	HVAC	Occup	Lighting	Equip	HVAC
1	0%	15%	15%	OFF	0%	15%	15%	OFF
2	0%	15%	15%	OFF	0%	15%	15%	OFF
3	0%	15%	15%	OFF	0%	15%	15%	OFF
4	0%	15%	15%	OFF	0%	15%	15%	OFF
5	0%	15%	15%	OFF	0%	15%	15%	OFF
6	0%	15%	15%	OFF	0%	15%	15%	OFF
7	0%	15%	15%	OFF	0%	15%	15%	OFF
8	15%	40%	65%	ON	0%	15%	15%	OFF
9	50%	90%	80%	ON	0%	15%	15%	OFF
10	70%	100%	100%	ON	0%	15%	15%	OFF
11	70%	100%	100%	ON	0%	15%	15%	OFF
12	70%	100%	100%	ON	0%	15%	15%	OFF
13	70%	100%	100%	ON	0%	15%	15%	OFF
14	70%	100%	100%	ON	0%	15%	15%	OFF
15	70%	100%	100%	ON	0%	15%	15%	OFF
16	70%	100%	100%	ON	0%	15%	15%	OFF
17	70%	100%	100%	ON	0%	15%	15%	OFF
18	40%	80%	80%	ON	0%	15%	15%	OFF
19	15%	60%	65%	OFF	0%	15%	15%	OFF
20	5%	60%	55%	OFF	0%	15%	15%	OFF
21	5%	50%	55%	OFF	0%	15%	15%	OFF
22	0%	15%	15%	OFF	0%	15%	15%	OFF
23	0%	15%	15%	OFF	0%	15%	15%	OFF
24	0%	15%	15%	OFF	0%	15%	15%	OFF
TOTAL	6.9	13.3	13.5	11	0	3.6	3.6	0

13.3.19 Industrial Working Spaces (>1 shift/day)

This profile should be used for warehouse spaces and production/manufacturing spaces, and any other spaces which operate with multiple shifts per day. This profile is based on 5 day per week operation; if the space is in use for longer, the profile should be adjusted accordingly.

Table 47: Industrial working space (>1 shift/day) operational profiles

Hour of Day	Weekday				Weekend			
	Occup	Lighting	Equip	HVAC	Occup	Lighting	Equip	HVAC
1	0%	15%	15%	OFF	0%	15%	15%	OFF
2	0%	15%	15%	OFF	0%	15%	15%	OFF
3	0%	15%	15%	OFF	0%	15%	15%	OFF
4	0%	15%	15%	OFF	0%	15%	15%	OFF
5	15%	40%	65%	ON	0%	15%	15%	OFF
6	50%	90%	80%	ON	0%	15%	15%	OFF
7	70%	100%	100%	ON	0%	15%	15%	OFF
8	70%	100%	100%	ON	0%	15%	15%	OFF
9	70%	100%	100%	ON	0%	15%	15%	OFF
10	70%	100%	100%	ON	0%	15%	15%	OFF
11	70%	100%	100%	ON	0%	15%	15%	OFF
12	70%	100%	100%	ON	0%	15%	15%	OFF
13	70%	100%	100%	ON	0%	15%	15%	OFF
14	70%	100%	100%	ON	0%	15%	15%	OFF
15	70%	100%	100%	ON	0%	15%	15%	OFF
16	70%	100%	100%	ON	0%	15%	15%	OFF
17	70%	100%	100%	ON	0%	15%	15%	OFF
18	70%	100%	100%	ON	0%	15%	15%	OFF
19	70%	100%	100%	ON	0%	15%	15%	OFF
20	70%	100%	100%	ON	0%	15%	15%	OFF
21	70%	100%	100%	ON	0%	15%	15%	OFF
22	40%	80%	80%	ON	0%	15%	15%	OFF
23	15%	60%	65%	OFF	0%	15%	15%	OFF
24	0%	15%	15%	OFF	0%	15%	15%	OFF
TOTAL	11.7	18.45	18.65	18	0	3.6	3.6	0

13.3.20 Industrial Working Spaces (24 hours/day)

This profile should be used for production/manufacturing spaces, and any other spaces which operate 24 hours per day. This profile is based on 5 day per week operation; if the space is in use for longer, the profile should be adjusted accordingly.

Table 48: Industrial working space (24 hour/day) operational profiles

Hour of Day	Weekday				Weekend			
	Occup	Lighting	Equip	HVAC	Occup	Lighting	Equip	HVAC
1	70%	100%	100%	ON	0%	15%	15%	OFF
2	70%	100%	100%	ON	0%	15%	15%	OFF
3	70%	100%	100%	ON	0%	15%	15%	OFF
4	70%	100%	100%	ON	0%	15%	15%	OFF
5	70%	100%	100%	ON	0%	15%	15%	OFF
6	70%	100%	100%	ON	0%	15%	15%	OFF
7	70%	100%	100%	ON	0%	15%	15%	OFF
8	70%	100%	100%	ON	0%	15%	15%	OFF
9	70%	100%	100%	ON	0%	15%	15%	OFF
10	70%	100%	100%	ON	0%	15%	15%	OFF
11	70%	100%	100%	ON	0%	15%	15%	OFF
12	70%	100%	100%	ON	0%	15%	15%	OFF
13	70%	100%	100%	ON	0%	15%	15%	OFF
14	70%	100%	100%	ON	0%	15%	15%	OFF
15	70%	100%	100%	ON	0%	15%	15%	OFF
16	70%	100%	100%	ON	0%	15%	15%	OFF
17	70%	100%	100%	ON	0%	15%	15%	OFF
18	70%	100%	100%	ON	0%	15%	15%	OFF
19	70%	100%	100%	ON	0%	15%	15%	OFF
20	70%	100%	100%	ON	0%	15%	15%	OFF
21	70%	100%	100%	ON	0%	15%	15%	OFF
22	70%	100%	100%	ON	0%	15%	15%	OFF
23	70%	100%	100%	ON	0%	15%	15%	OFF
24	70%	100%	100%	ON	0%	15%	15%	OFF
TOTAL	16.8	24.0	24.0	24	0	3.6	3.6	0

13.3.21 Industrial Retail, Factory Shop and Showroom

These profiles should be used for areas involved in the sale of goods, such as direct factory outlets. This profile is based on 6 day per week operation; if the space is in use for longer, the profile should be adjusted accordingly.

Table 49: Industrial retail, factory shop and showroom operational profiles

Hour of Day	Monday-Saturday				Sunday			
	Occup	Lighting	Equip	HVAC	Occup	Lighting	Equip	HVAC
1	0%	15%	15%	OFF	0%	15%	15%	OFF
2	0%	15%	15%	OFF	0%	15%	15%	OFF
3	0%	15%	15%	OFF	0%	15%	15%	OFF
4	0%	15%	15%	OFF	0%	15%	15%	OFF
5	0%	15%	15%	OFF	0%	15%	15%	OFF
6	0%	15%	15%	OFF	0%	15%	15%	OFF
7	0%	15%	15%	OFF	0%	15%	15%	OFF
8	10%	100%	70%	ON	0%	15%	15%	OFF
9	20%	100%	70%	ON	0%	15%	15%	OFF
10	20%	100%	70%	ON	0%	15%	15%	OFF
11	15%	100%	70%	ON	0%	15%	15%	OFF
12	25%	100%	70%	ON	0%	15%	15%	OFF
13	25%	100%	70%	ON	0%	15%	15%	OFF
14	15%	100%	70%	ON	0%	15%	15%	OFF
15	15%	100%	70%	ON	0%	15%	15%	OFF
16	15%	100%	70%	ON	0%	15%	15%	OFF
17	15%	100%	70%	ON	0%	15%	15%	OFF
18	5%	100%	70%	ON	0%	15%	15%	OFF
19	5%	100%	70%	OFF	0%	15%	15%	OFF
20	0%	15%	15%	OFF	0%	15%	15%	OFF
21	0%	15%	15%	OFF	0%	15%	15%	OFF
22	0%	15%	15%	OFF	0%	15%	15%	OFF
23	0%	15%	15%	OFF	0%	15%	15%	OFF
24	0%	15%	15%	OFF	0%	15%	15%	OFF
TOTAL	1.85	13.8	10.2	11	0	3.6	3.6	0

13.3.22 Common Area

These profiles should be used for foyers, lobbies, reception areas, break-out spaces, lunch rooms, and small gymnasia or fitness rooms. This profile is based on 5 day per week operation; if the space is in use for longer, the profile should be adjusted accordingly.

Table 50: Common areas operational profiles

Hour of Day	Monday-Saturday				Sunday			
	Occup	Lighting	Equip	HVAC	Occup	Lighting	Equip	HVAC
1	0%	15%	15%	OFF	0%	15%	15%	OFF
2	0%	15%	15%	OFF	0%	15%	15%	OFF
3	0%	15%	15%	OFF	0%	15%	15%	OFF
4	0%	15%	15%	OFF	0%	15%	15%	OFF
5	0%	15%	15%	OFF	0%	15%	15%	OFF
6	0%	15%	15%	OFF	0%	15%	15%	OFF
7	20%	100%	100%	ON	0%	15%	15%	OFF
8	50%	100%	100%	ON	0%	15%	15%	OFF
9	5%	100%	100%	ON	0%	15%	15%	OFF
10	0%	100%	100%	ON	0%	15%	15%	OFF
11	5%	100%	100%	ON	0%	15%	15%	OFF
12	85%	100%	100%	ON	0%	15%	15%	OFF
13	100%	100%	100%	ON	0%	15%	15%	OFF
14	5%	100%	100%	ON	0%	15%	15%	OFF
15	0%	100%	100%	ON	0%	15%	15%	OFF
16	50%	100%	100%	ON	0%	15%	15%	OFF
17	0%	100%	100%	ON	0%	15%	15%	OFF
18	20%	100%	100%	ON	0%	15%	15%	OFF
19	20%	100%	100%	ON	0%	15%	15%	OFF
20	0%	15%	15%	OFF	0%	15%	15%	OFF
21	0%	15%	15%	OFF	0%	15%	15%	OFF
22	0%	15%	15%	OFF	0%	15%	15%	OFF
23	0%	15%	15%	OFF	0%	15%	15%	OFF
24	0%	15%	15%	OFF	0%	15%	15%	OFF
TOTAL	3.6	14.65	14.65	13	0	3.6	3.6	0

13.3.23 Fire Stations

These profiles should be used for the sleeping and living areas of fire stations; administrative and equipment areas should use the relevant profiles from other sections. Profiles are given separately for sleeping and other areas; both of these apply 7 days per week.

Table 51: Fire station sleeping and living area operational profiles

Hour of Day	Sleeping Areas				Living Areas			
	Occup	Lighting	Equip	HVAC	Occup	Lighting	Equip	HVAC
1	100%	0%	100%	ON	100%	100%	100%	ON
2	100%	0%	100%	ON	100%	100%	100%	ON
3	100%	0%	100%	ON	100%	100%	100%	ON
4	100%	0%	100%	ON	100%	100%	100%	ON
5	100%	0%	100%	ON	100%	100%	100%	ON
6	100%	0%	100%	ON	100%	100%	100%	ON
7	0%	100%	100%	ON	100%	50%	100%	ON
8	0%	100%	100%	ON	100%	50%	100%	ON
9	0%	0%	100%	ON	100%	50%	100%	ON
10	0%	0%	100%	ON	100%	50%	100%	ON
11	0%	0%	100%	ON	100%	50%	100%	ON
12	0%	0%	100%	ON	100%	50%	100%	ON
13	0%	0%	100%	ON	100%	50%	100%	ON
14	0%	0%	100%	ON	100%	50%	100%	ON
15	0%	0%	100%	ON	100%	50%	100%	ON
16	0%	0%	100%	ON	100%	50%	100%	ON
17	0%	0%	100%	ON	100%	50%	100%	ON
18	0%	0%	100%	ON	100%	50%	100%	ON
19	0%	100%	100%	ON	100%	100%	100%	ON
20	0%	100%	100%	ON	100%	100%	100%	ON
21	0%	100%	100%	ON	100%	100%	100%	ON
22	0%	100%	100%	ON	100%	100%	100%	ON
23	100%	100%	100%	ON	100%	100%	100%	ON
24	100%	0%	100%	ON	100%	100%	100%	ON
TOTAL	8.0	7.0	24.0	24	24.0	18.0	24.0	24

13.3.24 Retail Stores

This profile should be used for all speciality retail, mini majors, majors, department stores and food and beverage outlets. It can be used for standalone retail outlets, and those in retail shopping centres and strip malls. This profile is based on 6 day per week operation; if the space is in use for longer, the profile should be adjusted accordingly.

Table 52: Retail centre stores operational profiles

Hour of Day	Monday-Saturday				Sunday			
	Occup	Lighting	Equip	HVAC	Occup	Lighting	Equip	HVAC
1	0%	5%	0%	OFF	0%	5%	0%	OFF
2	0%	5%	0%	OFF	0%	5%	0%	OFF
3	0%	5%	0%	OFF	0%	5%	0%	OFF
4	0%	5%	0%	OFF	0%	5%	0%	OFF
5	0%	5%	0%	OFF	0%	5%	0%	OFF
6	0%	5%	0%	OFF	0%	5%	0%	OFF
7	0%	5%	0%	OFF	0%	5%	0%	OFF
8	10%	100%	100%	ON	0%	5%	0%	OFF
9	85%	100%	100%	ON	0%	5%	0%	OFF
10	100%	100%	100%	ON	0%	5%	0%	OFF
11	95%	100%	100%	ON	0%	5%	0%	OFF
12	95%	100%	100%	ON	0%	5%	0%	OFF
13	75%	100%	100%	ON	0%	5%	0%	OFF
14	75%	100%	100%	ON	0%	5%	0%	OFF
15	50%	100%	100%	ON	0%	5%	0%	OFF
16	50%	100%	100%	ON	0%	5%	0%	OFF
17	50%	100%	100%	ON	0%	5%	0%	OFF
18	0%	5%	0%	OFF	0%	5%	0%	OFF
19	0%	5%	0%	OFF	0%	5%	0%	OFF
20	0%	5%	0%	OFF	0%	5%	0%	OFF
21	0%	5%	0%	OFF	0%	5%	0%	OFF
22	0%	5%	0%	OFF	0%	5%	0%	OFF
23	0%	5%	0%	OFF	0%	5%	0%	OFF
24	0%	5%	0%	OFF	0%	5%	0%	OFF
TOTAL	6.85	10.7	10.0	10	0	1.2	0	0

13.3.25 Retail Centre Public Spaces Areas

This profile should be used for all malls, food court, amenities and promotional areas. This profile is based on 6 day per week operation; if the space is in use for longer, the profile should be adjusted accordingly.

Table 53: Retail centre public spaces operational profiles

Hour of Day	Monday-Saturday				Sunday			
	Occup	Lighting	Equip	HVAC	Occup	Lighting	Equip	HVAC
1	0%	5%	0%	OFF	0%	5%	0%	OFF
2	0%	5%	0%	OFF	0%	5%	0%	OFF
3	0%	5%	0%	OFF	0%	5%	0%	OFF
4	0%	5%	0%	OFF	0%	5%	0%	OFF
5	0%	5%	0%	OFF	0%	5%	0%	OFF
6	0%	5%	0%	OFF	0%	5%	0%	OFF
7	0%	5%	0%	OFF	0%	5%	0%	OFF
8	0%	100%	100%	ON	0%	5%	0%	OFF
9	85%	100%	100%	ON	0%	5%	0%	OFF
10	85%	100%	100%	ON	0%	5%	0%	OFF
11	100%	100%	100%	ON	0%	5%	0%	OFF
12	100%	100%	100%	ON	0%	5%	0%	OFF
13	95%	100%	100%	ON	0%	5%	0%	OFF
14	95%	100%	100%	ON	0%	5%	0%	OFF
15	95%	100%	100%	ON	0%	5%	0%	OFF
16	75%	100%	100%	ON	0%	5%	0%	OFF
17	50%	100%	100%	ON	0%	5%	0%	OFF
18	0%	5%	0%	OFF	0%	5%	0%	OFF
19	0%	5%	0%	OFF	0%	5%	0%	OFF
20	0%	5%	0%	OFF	0%	5%	0%	OFF
21	0%	5%	0%	OFF	0%	5%	0%	OFF
22	0%	5%	0%	OFF	0%	5%	0%	OFF
23	0%	5%	0%	OFF	0%	5%	0%	OFF
24	0%	5%	0%	OFF	0%	5%	0%	OFF
TOTAL	7.8	10.7	10.0	10	0	1.2	0	0

13.3.26 Retail Centre Back of House

This profile should be used for back of house areas which are continuously occupied during retail centre operating hours.

Table 54: Retail centre back of house operational profiles

Hour of Day	Monday-Saturday				Sunday			
	Occup	Lighting	Equip	HVAC	Occup	Lighting	Equip	HVAC
1	0%	15%	15%	OFF	0%	15%	15%	OFF
2	0%	15%	15%	OFF	0%	15%	15%	OFF
3	0%	15%	15%	OFF	0%	15%	15%	OFF
4	0%	15%	15%	OFF	0%	15%	15%	OFF
5	0%	15%	15%	OFF	0%	15%	15%	OFF
6	0%	15%	15%	OFF	0%	15%	15%	OFF
7	25%	40%	40%	OFF	0%	15%	15%	OFF
8	50%	90%	90%	ON	0%	15%	15%	OFF
9	100%	100%	100%	ON	0%	15%	15%	OFF
10	100%	100%	100%	ON	0%	15%	15%	OFF
11	100%	100%	100%	ON	0%	15%	15%	OFF
12	100%	100%	100%	ON	0%	15%	15%	OFF
13	100%	100%	100%	ON	0%	15%	15%	OFF
14	100%	100%	100%	ON	0%	15%	15%	OFF
15	100%	100%	100%	ON	0%	15%	15%	OFF
16	100%	100%	100%	ON	0%	15%	15%	OFF
17	50%	80%	80%	ON	0%	15%	15%	OFF
18	0%	60%	60%	OFF	0%	15%	15%	OFF
19	0%	60%	60%	OFF	0%	15%	15%	OFF
20	0%	15%	15%	OFF	0%	15%	15%	OFF
21	0%	15%	15%	OFF	0%	15%	15%	OFF
22	0%	15%	15%	OFF	0%	15%	15%	OFF
23	0%	15%	15%	OFF	0%	15%	15%	OFF
24	0%	15%	15%	OFF	0%	15%	15%	OFF
TOTAL	9.25	12.95	12.95	10	0	3.6	3.6	0

13.3.27 Car Parks and Loading Docks

This profile should be used for all internal car parks and loading docks for any building type. It is based on operation 6 days per week. In buildings which operate for longer or shorter periods, the profile should be adjusted accordingly.

Table 55: Car park and loading dock operational profiles

Hour of Day	Monday-Saturday				Sunday			
	Occup	Lighting	Equip	HVAC	Occup	Lighting	Equip	HVAC
1	0%	0%	0%	OFF	0%	0%	0%	OFF
2	0%	0%	0%	OFF	0%	0%	0%	OFF
3	0%	0%	0%	OFF	0%	0%	0%	OFF
4	0%	0%	0%	OFF	0%	0%	0%	OFF
5	0%	0%	0%	OFF	0%	0%	0%	OFF
6	0%	0%	0%	OFF	0%	0%	0%	OFF
7	0%	0%	0%	OFF	0%	0%	0%	OFF
8	0%	0%	0%	OFF	0%	0%	0%	OFF
9	0%	100%	100%	ON	0%	0%	0%	OFF
10	0%	100%	100%	ON	0%	0%	0%	OFF
11	0%	100%	100%	ON	0%	0%	0%	OFF
12	0%	100%	100%	ON	0%	0%	0%	OFF
13	0%	100%	100%	ON	0%	0%	0%	OFF
14	0%	100%	100%	ON	0%	0%	0%	OFF
15	0%	100%	100%	ON	0%	0%	0%	OFF
16	0%	100%	100%	ON	0%	0%	0%	OFF
17	0%	100%	100%	ON	0%	0%	0%	OFF
18	0%	100%	100%	ON	0%	0%	0%	OFF
19	0%	0%	0%	OFF	0%	0%	0%	OFF
20	0%	0%	0%	OFF	0%	0%	0%	OFF
21	0%	0%	0%	OFF	0%	0%	0%	OFF
22	0%	0%	0%	OFF	0%	0%	0%	OFF
23	0%	0%	0%	OFF	0%	0%	0%	OFF
24	0%	0%	0%	OFF	0%	0%	0%	OFF
TOTAL	0	10.0	10.0	10	0	0	0	0

13.3.28 External Lighting

This profile should be used for external lighting applications including pathway lighting, decorative lighting, landscape lighting and external car park lighting. It does not include external lighting for sports events. Three profile types are given, as follows:

- Normal: to be used when all parts of a project function for no more than 12 hours per day during normal business hours;
- Long: to be used when any part of a project operates for more than 12 hours but less than 20 hours per day; and
- 24 hour: to be used when any part of a project operates for more than 20 hours per day.

Where a project operates less than 7 days per week, the applicable profile shall be used for all operating days, and the Normal profile for all other days.

Table 56: External lighting operational profiles

Hour of Day	Normal	Long	24-hour
1	15%	15%	100%
2	15%	15%	100%
3	15%	15%	100%
4	15%	100%	100%
5	15%	100%	100%
6	15%	100%	100%
7	0%	0%	0%
8	0%	0%	0%
9	0%	0%	0%
10	0%	0%	0%
11	0%	0%	0%
12	0%	0%	0%
13	0%	0%	0%
14	0%	0%	0%
15	0%	0%	0%
16	0%	0%	0%
17	0%	0%	0%
18	0%	0%	0%
19	100%	0%	100%
20	15%	0%	100%
21	15%	100%	100%
22	15%	100%	100%
23	15%	100%	100%
24	15%	15%	100%
TOTAL	2.65	6.6	12.0

13.3.29 Multi-Unit Residential Living Space (including Kitchen)

These profiles should be used for the primary living space within an apartment and for the kitchen space if separate.

Table 57: Apartment living space (including kitchen) operational profiles

Hour of Day	All Days				
	Occup	Lighting	Equip-Sens	Equip-Latent	HVAC
1	0%	0%	9.1%	0%	OFF
2	0%	0%	9.1%	0%	OFF
3	0%	0%	9.1%	0%	OFF
4	0%	0%	9.1%	0%	OFF
5	0%	0%	9.1%	0%	OFF
6	0%	0%	9.1%	0%	OFF
7	0%	0%	9.1%	0%	OFF
8	100%	60%	36.4%	40.3%	ON
9	100%	60%	9.1%	9.3%	ON
10	50%	0%	9.1%	4.7%	ON
11	50%	0%	9.1%	4.7%	ON
12	50%	0%	9.1%	4.7%	ON
13	50%	0%	9.1%	4.7%	ON
14	50%	0%	9.1%	4.7%	ON
15	50%	0%	9.1%	4.7%	ON
16	50%	0%	9.1%	4.7%	ON
17	50%	0%	9.1%	4.7%	ON
18	75%	100%	9.1%	7.0%	ON
19	75%	100%	100%	100%	ON
20	75%	100%	22.7%	7.0%	ON
21	75%	100%	22.7%	7.0%	ON
22	75%	100%	22.7%	7.0%	ON
23	0%	0%	9.1%	0%	ON
24	0%	0%	9.1%	0%	ON
TOTAL	9.75	6.2	3.77	2.15	17

13.3.30 Multi-Unit Residential Living Space (excluding Kitchen)

These profiles should be used for any secondary living spaces, and for all corridors and amenity spaces within an apartment.

Table 58: Apartment living space (excluding kitchen) operational profiles

Hour of Day	All Days				
	Occup	Lighting	Equip-Sens	Equip-Latent	HVAC
1	0%	0%	0%	0%	OFF
2	0%	0%	0%	0%	OFF
3	0%	0%	0%	0%	OFF
4	0%	0%	0%	0%	OFF
5	0%	0%	0%	0%	OFF
6	0%	0%	0%	0%	OFF
7	0%	0%	0%	0%	OFF
8	100%	60%	0%	0%	ON
9	100%	60%	0%	0%	ON
10	50%	0%	0%	0%	ON
11	50%	0%	0%	0%	ON
12	50%	0%	0%	0%	ON
13	50%	0%	0%	0%	ON
14	50%	0%	0%	0%	ON
15	50%	0%	0%	0%	ON
16	50%	0%	0%	0%	ON
17	50%	0%	0%	0%	ON
18	75%	100%	0%	0%	ON
19	75%	100%	0%	0%	ON
20	75%	100%	0%	0%	ON
21	75%	100%	0%	0%	ON
22	75%	100%	0%	0%	ON
23	0%	0%	0%	0%	ON
24	0%	0%	0%	0%	ON
TOTAL	9.75	6.2	0	0	17

13.3.31 Multi-Unit Residential Bedroom

These profiles should be used for all bedrooms within an apartment.

Table 59: Apartment bedroom operational profiles

Hour of Day	All Days				
	Occup	Lighting	Equip-Sens	Equip-Latent	HVAC
1	100%	0%	0%	0%	ON
2	100%	0%	0%	0%	ON
3	100%	0%	0%	0%	ON
4	100%	0%	0%	0%	ON
5	100%	0%	0%	0%	ON
6	100%	0%	0%	0%	ON
7	100%	0%	0%	0%	ON
8	0%	0%	0%	0%	ON
9	0%	0%	0%	0%	ON
10	0%	0%	0%	0%	OFF
11	0%	0%	0%	0%	OFF
12	0%	0%	0%	0%	OFF
13	0%	0%	0%	0%	OFF
14	0%	0%	0%	0%	OFF
15	0%	0%	0%	0%	OFF
16	0%	0%	0%	0%	OFF
17	0%	0%	0%	0%	ON
18	0%	0%	0%	0%	ON
19	0%	0%	0%	0%	ON
20	0%	100%	0%	0%	ON
21	0%	100%	0%	0%	ON
22	0%	100%	0%	0%	ON
23	100%	100%	0%	0%	ON
24	100%	0%	0%	0%	ON
TOTAL	9.0	4.0	0	0	17

13.3.32 Multi-Unit Residential Common Areas

These profiles should be used for common areas such as foyers, lobbies, hallways and corridors areas (i.e. areas which are not part of a private dwelling).

Table 60: Multi-unit residential common area operational profiles

Hour of Day	All Days				
	Occup	Lightin g	Equip-Sens	Equip-Latent	HVAC
1	0%	0%	0%	0%	OFF
2	0%	0%	0%	0%	OFF
3	0%	0%	0%	0%	OFF
4	0%	0%	0%	0%	OFF
5	0%	0%	0%	0%	OFF
6	0%	50%	0%	0%	OFF
7	0%	50%	0%	0%	ON
8	0%	100%	0%	0%	ON
9	0%	100%	0%	0%	ON
10	0%	100%	0%	0%	ON
11	0%	100%	0%	0%	ON
12	0%	50%	0%	0%	ON
13	0%	50%	0%	0%	ON
14	0%	50%	0%	0%	ON
15	0%	50%	0%	0%	ON
16	0%	50%	0%	0%	ON
17	0%	50%	0%	0%	ON
18	0%	100%	0%	0%	ON
19	0%	100%	0%	0%	ON
20	0%	100%	0%	0%	ON
21	0%	100%	0%	0%	ON
22	0%	100%	0%	0%	ON
23	0%	100%	0%	0%	ON
24	0%	50%	0%	0%	ON
TOTAL	0	14.5	0	0	18

13.4 Supplementary Building and Systems - Definitions and Calculation Methods

13.4.1 Refrigerated Cool Room and Cold Room Wall Construction

Where refrigerated cool rooms and/or cold rooms are present, the assumed construction for the Reference Project shall be taken as follows:

Table 61: Reference Project construction for refrigerated cool rooms and cold rooms

Construction (outside to inside of refrigerated room)	R value (m² K/W)
Concrete (100mm) Insulation (90mm) Cavity (50mm) Composite Panel (25mm)	4.17

13.5 Reference Project HVAC Systems

For Green Star – Design & As Built projects the Reference Project HVAC system shall use the same airside configuration, zoning and components as the Proposed Project. The waterside configuration shall consist of a simple chiller, boiler and pumping configuration serving heating/cooling coil demands.

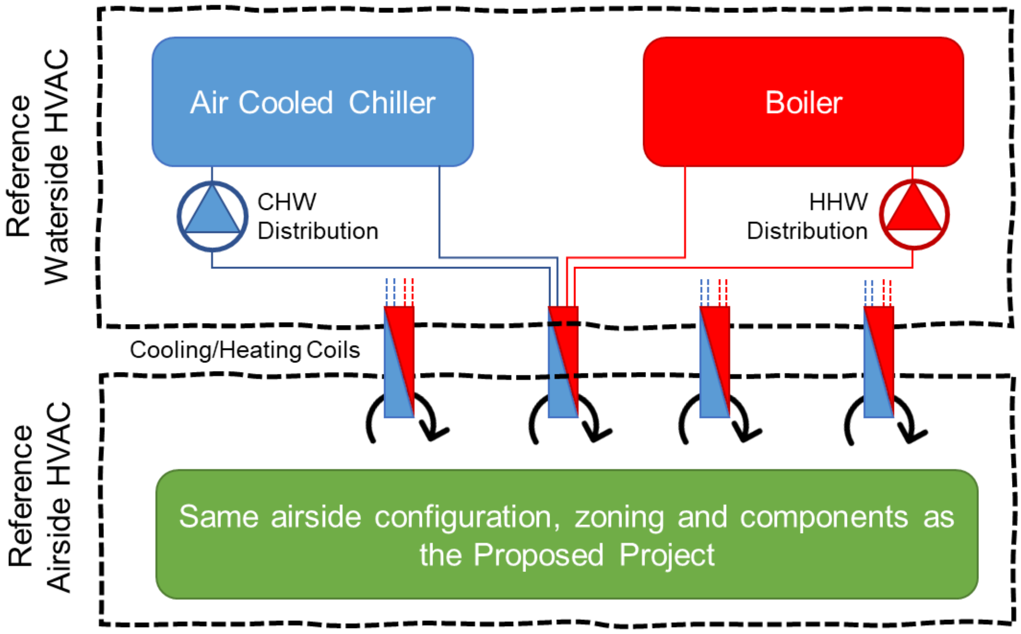

Figure 2: Reference HVAC airside and waterside definition

"Waterside HVAC" refers to all components and systems associated with heat transfer occurring within piped networks between cooling/heating coils and external heat rejection systems.

"Airside HVAC" refers to all components and systems associated with the distribution of air for the purposes of heating, cooling and ventilation.

The intent is that the Proposed Project Airside HVAC model should be re-used for the Reference Project model with changes to system sizing, ventilation rates and controls, component efficiency, and the addition of heat recovery and economiser (where required).

All Reference HVAC requirements are provided in Table 62. Typical examples of Proposed and Reference definitions are provided in Table 63.

Table 62: Reference Project HVAC system design and operating parameters

Item	HVAC System Component	Reference Building Model HVAC System Description
1	HVAC system type	**Airside Configuration** The same airside system configuration and components as the Proposed Project. Where a space in the Proposed Project is naturally ventilated and no active cooling is provided the reference building shall assume a 4-pipe fan coil system configuration with a single outdoor air unit providing ventilation to all spaces. Where the proposed project utilises displacement ventilation systems the reference may be re-modelled as an overhead distribution system with similar airside component configurations and zoning. **Waterside Configuration** Air source chiller and electric boiler with single constant volume pumping for heating and cooling coils.
2	System zoning	The same as the Proposed Project
3	Outdoor air rate	NZBC minimum outdoor air rate for each conditioned space If space type not covered under NZBC use the same outdoor air rate as in the Proposed Project **For Building Classified as Commercial in NZBC** Clause H1/VM3 takes precedence and requires deactivation of outdoor air in accordance with NZBC H1/VM3 Clause 3.2.2
4	Supply air temperature cooling	10°C less than design cooling space temperature for each conditioned zone Supply air cooling temperature shall operate as defined above during all operating hours Reheat capacity limited to 7.5K – additional zoning may be provided in the Reference building where space conditioning requirements cannot be achieved.
5	Supply air temperature heating	10°C more than design heating space temperature for each conditioned zone Supply air heating temperature shall operate as defined above during all operating hours
6	Supply air flowrate	To achieve design conditions in each conditioned zone using the supply air temperatures listed above; OR Additional supply air flowrate that is required to balance extraction
7	Exhaust air flowrate	Up to 20% of the minimum outdoor air rate may be treated as lost to the system (e.g. building pressurization) and therefore not used for return or exhaust air flows/heat exchange

8	Heating plant seasonal efficiency	90% thermal efficiency	
9	Cooling plant EER	(<528kW)	Full Load EER – 2.985 IPLV – 4.048
		(>528kW)	Full Load EER – 2.985 IPLV – 4.137
10	HVAC and Process Ventilation Fans	HVAC Fans shall be sized to achieve the Reference Project duties (volume and pressure). Fan Motor Input Power shall be based on the minimum efficiency calculations provided in NZBC H1/VM3 Section 4.2. Where fans are less than 1000l/s the Reference Project Fan Motor Input Power of 0.65W/l/s. may be used as an alternative to the H1/VM3 efficiency method.	
11	HVAC Pumps	HVAC Pumps shall be sized to achieve the Reference Project duties (volumes and total system pressures) The Pump Motor Input Power shall be based on the minimum efficiency calculations provided in NZBC H1/VM3. Use same Pressure Drop as the Proposed system total pumping arrangement (including both Primary and Secondary systems where applicable).	
12	Fan system operation	Air conditioning and mechanical ventilation fans shall operate continuously during operating hours. **For Building Classified as Commercial in NZBC** Clause H1/VM3 takes precedence and requires any mechanical components serving a conditioned space with a supply air rate of greater than 1000l/s, including as part of an air conditioning system, shall vary its speed in accordance with the required airflow rates unless there is a clear functional requirement for constant volume airflow. **For Building Classified as Commercial in NZBC** Clause H1/VM3 takes precedence and requires deactivation for exhaust systems in accordance with NZBC H1/VM3 Clause 3.2.2 Process ventilation fans shall operate to the same profiles of use as the Proposed Project.	
13	Chilled water and heating water pumps operation	Constant speed chilled water and heating hot water pumps shall operate continuously during plant operating hours.	
14	Exhaust air heat recovery	For reference project mechanical components serving a conditioned space with greater than 1000l/s outdoor air, including as part of an air conditioning system, provide a heat recovery system with a sensible heat recovery effectiveness of 60%.	

		For Building Classified as Commercial in NZBC demand control ventilation in accordance with AS1668.2 may be utilised in lieu of heat recovery.
15	Economiser	For reference project airside components, with total airflow rates greater than 2500l/s, provide an economiser.
16	Economiser high-limit shutoff	Dependent on NZBC H1 Climate Zone: Climate Zone 1 = 18°C Climate zones 2-6 = 21°C

Refer to Section 6.1.1 for Process load inclusions. **Figure** below provides a visual summary of Process Loads included and excluded in the Proposed and Reference Projects.

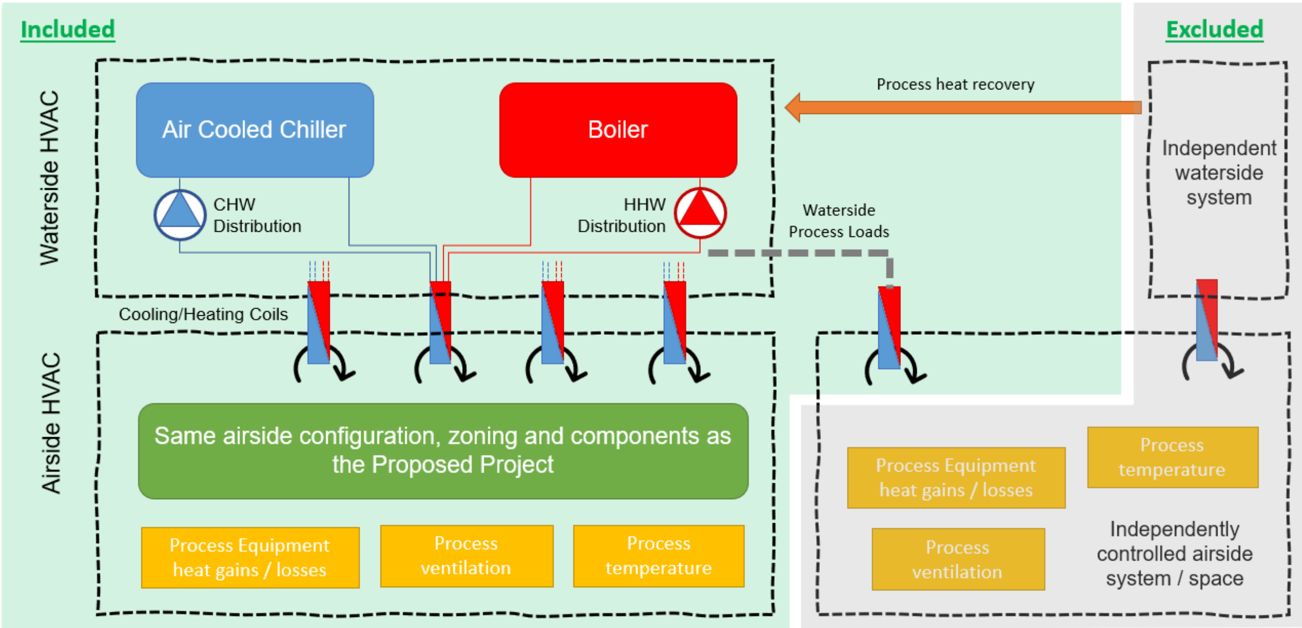

Figure 3: Process load inclusions and exclusions

Table 63: Reference Airside HVAC Configuration Examples

Proposed Project System	Example Reference Project Description
Variable Air Volume (VAV) System	Proposed AHU and terminal unit conditioning arrangement and zoning. Proposed outdoor air, supply air, return air and spill air pathways. Components re-sized to deliver to Reference Project loads. AHU fans running as constant volume, no demand controlled outdoor air, heat exchanger when outdoor air exceeds 1000l/s, economiser if AHU supply air exceeds 2500l/s. Terminal units providing reheat with 7.5K limit All coil loads met by Reference Waterside HVAC Definition **Similar to a Constant Air Volume (CAV) System with terminal heating**
Package Unit	Proposed Package Unit zoning Proposed outdoor air, supply air, return air and spill air pathways

	Components re-sized to deliver to Reference Project loads. All fans running as constant volume, no demand controlled outdoor air, heat exchanger when outdoor air exceeds 1000l/s, economiser if AHU supply air exceeds 2500l/s. All coil loads met by Reference Waterside HVAC Definition **Similar to a Constant Air Volume (CAV) System**
Fan Coil Units (FCU)	Proposed FCU and outdoor air handling arrangement and zoning. Proposed outdoor air and spill air pathways. Components re-sized to deliver to Reference Project loads. All fans running as constant volume, no demand controlled outdoor air, heat exchanger when outdoor air unit volumes exceed 1000l/s. All supply air volumes less than 2500l/s – no economiser. All coil loads met by Reference Waterside HVAC Definition **Similar to a Fan Coil Unit (FCU) System**
VRF / Split Units	Proposed Indoor Unit and outdoor air handling arrangement and zoning. Proposed outdoor air and spill air pathways. Components re-sized to deliver to Reference Project loads. All fans running as constant volume, no demand controlled outdoor air, heat exchanger when outdoor air unit volumes exceed 1000l/s. All supply air volumes less than 2500l/s – no economiser. All coil loads met by Reference Waterside HVAC Definition **Similar to a Fan Coil Unit (FCU) System**
Displacement System	Proposed AHU conditioning arrangement and zoning. Proposed outdoor air and spill air pathways. Overhead supply air distribution and return Components re-sized to deliver to Reference Project loads. AHU fans running as constant volume, no demand controlled outdoor air, heat exchanger when outdoor air exceeds 1000l/s, economiser if AHU supply air exceeds 2500l/s. All coil loads met by Reference Waterside HVAC Definition **Similar to a Constant Air Volume (CAV) System**
Chilled Beams	Proposed AHU and terminal unit conditioning arrangement and zoning. Proposed outdoor air, supply air, return air and spill air pathways. Components re-sized to deliver to Reference Project loads. AHU fans running as constant volume, no demand controlled outdoor air, heat exchanger when outdoor air exceeds 1000l/s, economiser if AHU supply air exceeds 2500l/s. Terminal units providing supplementary cooling up to 7.5K All coil loads met by Reference Waterside HVAC Definition **Similar to a Constant Air Volume (CAV) System with terminal cooling**
Natural Ventilation with Local Radiators / Convectors	**Model as FCU System**

13.5.1 Variable Air Volume Fan Speed Control

Where the Proposed or Reference Project contains variable air volume (VAV) systems their part-load performance characteristics shall be modelled using Method 1 given below (based on clause G3.1.3.15

(ASHRAE, 2007)). Where the Proposed Project adopts system pressure optimisation reset control, Method 2 may be applied:

13.5.1.1 Method 1 – Part-Load Fan Power Equation for Standard Control

$$P_{fan} = 0.0013 + 0.1470PLR_{fan} + 0.9506PLR_{fan}^2 - 0.0998PLR_{fan}^3$$

Where P_{fan} is the proportion of full-load fan power used at any given fan part-load ratio, and PLR_{fan} is the fan part-load ratio (ratio of actual system air flow rate (m³/s) in any given hour to the design system air flow rate (m³/s)).

13.5.1.2 Method 2 – Part-Load Fan Power Equation for System Pressure Optimisation Reset Control

$$P_{fan} = 0.0012 - 0.0579PLR_{fan} + 0.5864PLR_{fan}^2 + 0.4712PLR_{fan}^3$$

Where definitions of variables P_{fan} and PLR_{fan} are as per Method 1.

The difference in proportion of full-load fan power calculated using these methods is illustrated in Figure 4:

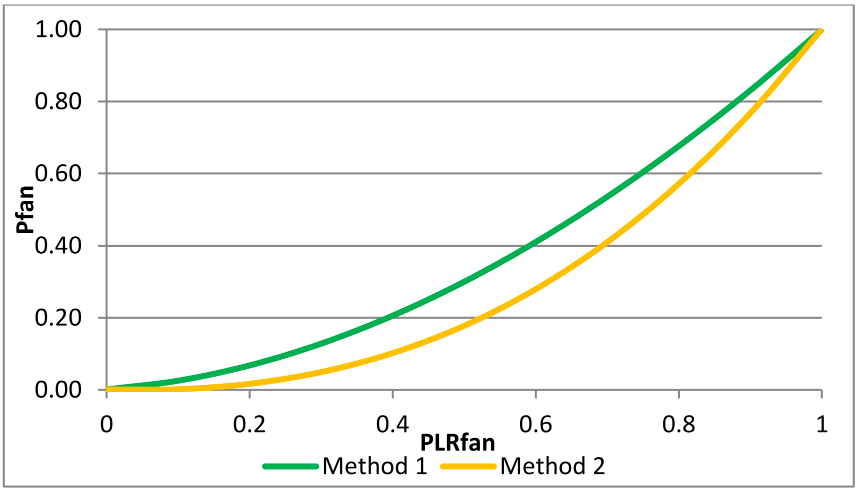

Figure 4: Proportion of full-load fan power for Method 1 and Method 2

13.5.2 External Artificial Lighting

Lighting power densities to be applied for the Reference Project (and Proposed Project where minimum illuminance values as per AS 1158.3.1 are not achieved by the design) shall be applied according to the usage category as follows:

Table 64: Standard practice external lighting power densities

Category	Power Density	Category	Power Density
P1 (note 1)	7.1 W/m	P8	0.8 W/m²
P2 (note 1)	4.3 W/m	P9	Match adjacent category
P3 (note 1)	3.5 W/m	P10	1.7 W/m²
P4 (note 1)	2.6 W/m	P11a	1.5 W/m²
P5 (note 1)	2.2 W/m	P11b	0.6 W/m²
P6	2.1 W/m²	P11c	0.2 W/m²
P7	1.4 W/m²	P12	9.0 W/m²

Notes

1: Based on path widths up to 6 metres. For path widths greater than 6 metres, multiply power density by number of 6 metre widths or part thereof, e.g. if path is 8 metres wide, this is 1.33 widths, therefore multiply by 2.

13.5.3 Lift Energy Consumption Methodology

Estimation of the Proposed and Reference Project annual lift energy consumption shall be based on the following methodology (adapted from Barney, 2007):

$$E = N\frac{\bar{T}_{trip}}{3600}\dot{Q}_{avg} + \dot{Q}_{standby}T_{standby}D_{standby}$$

Where E is the annual energy consumption of the lift (kWh/annum), N is the number of lift trips, $\bar{T}_{trip}$ is the average trip time (s), $\dot{Q}_{avg}$ is the average motor load (kW), $\dot{Q}_{standby}$ is the lift standby power (kW), $T_{standby}$ is the hours of lift standby operation (hours/day), and $D_{standby}$ is the number of days of lift standby operation (days/annum). Average trip time is calculated as follows:

$$\bar{T}_{trip} = \frac{H}{2v_{rated}}$$

Where H is the total travel distance of the lift between terminal floors (m), and v_{rated} is the rated travel speed of the lift (m/s) (the factor of 2 is introduced based on the assumption that the average travel distance is half of the total travel distance).

This formula should be used for both the Proposed and Reference Project. The design team needs to establish the trip time, lift power rating and standby power for the Proposed Project (definitions below). All other parameters for the Proposed Project and all parameters for the Reference Project are given in Table below.

Table 65: Lift energy consumption calculation input parameters

Parameter	Definition	Proposed Project	Reference Project
Number of trips	The standard number of trips per year for the relevant project type.	The number of trips for the Proposed Project should be taken from Table 67.	As Proposed Project
Average trip time	The time, in seconds, for the lift to travel half the possible travel distance measured from doors closed to doors opening.	This parameter needs to be calculated by the design team. It will depend on the distance the lift will travel and the rated speed of the lift.	The travel distance is the same as the Proposed Project. The rated speed of the Reference Project lifts shall be taken as the smaller value of 8 m/s and H/T, where T is the nominal travel time between terminal floors (refer to Table 67) (CIBSE, 2005).
Average power load	The average power load is assumed to be the lift motor rated power (kW).	From design calculations or supplier specifications for the lift being assessed. This figure can be reduced by 20% if the lift has regenerative breaks.	The rated motor power shall be calculated based on the specified lift rated speed and rated carrying capacity (kg) assuming overhead electric traction with gearless variable voltage variable frequency (VVVF) drives, roping factor of 2:1, counterbalance of 0.5, and 100% compensation for rated speeds greater than 2.5 m/s (refer to equation below).
Standby power	Standby power from car lights and lift control system.	From supplier specifications for lift being assessed.	0.15 kW
Standby hours per day	Number of hours per day that the car lights and lift control systems are operating.	24 hours unless the lift has a power off feature, in which case the figure used should be 18 hours.	24 hours
Standby days per year	Number of days the standby power is applicable.	365 days, except for offices and education facilities where the lift has a power off feature in which case the number of weekdays less the number of public holidays should be used.	365 days

Reference Project rated motor power shall be calculated using the following equation:

$$\dot{Q} = \frac{1.05 g f_{roping} v_{rated}}{1000}\left(\frac{M}{f_{roping}}(1-B) - \frac{H}{2}\left(\frac{M_t N_t}{2} + 2M_c N_c - 2M_s N_s\right)\right) + 0.5$$

Where $\dot{Q}$ is the lift motor rated power (kW), g is acceleration due to gravity (9.81 m/s²), f_{roping} is the roping factor (2 for the Reference Project lifts), v_{rated} is the lift rated travel speed (m/s), M is the lift rated carrying capacity (kg), B is the counterbalance proportion of total lift car mass (0.5 for the Reference Project lifts), H is the total travel distance of the lift between terminal floors (m) (as per the Proposed Project), M_t, M_c and M_s are the mass per unit length of the travelling cables, compensator cables and main cables, respectively (kg/m) (0.43, 1.0 and 1.0 kg/m, respectively, for the Reference Project lifts), and N_t, N_c and N_s are the number of travelling cables, compensator cables and main cables, respectively (4, 6 and 6, respectively, for the Reference Project lifts). Note that for lifts without compensation (rated speed less than 2.5 m/s), $M_c = N_c = 0$.

Table 66: Lift trips by project usage

Lift Duty	Trips per day	Building types (lift operating days/week)	Trips per year		
			5 days/week (260 days/year)	6 days/week (312 days/year)	7 days/week (365 days/year)
Low	200	Residential care (7) Goods lifts (5) Library (6) Entertainment centres (7)	52,000	62,400	73,000
Medium	600	Office car parks (5) General car parks (7) Residential (7) University (5) Hotels (7) Low-rise hospitals (7) Shopping centres (7)	156,000	NA	219,000
High	1500	Office (5) Airports (7) High-rise hospitals (7)	390,000	NA	547,500
Intensive	2000	HQ office (5)	520,000	NA	NA

Table 67: Reference Project nominal lift travel time between terminal floors

Building Type	Travel time between terminal floors (s)
Large offices, hotels, etc	20
Small offices, hotels, etc	20
Hospitals, nursing and residential homes, etc	24
Residential buildings	25
Factories, warehouses, retail, etc	30

Note that DDA access lifts having travel distances of one storey or less are not required to be included as their energy consumption is negligible.

As an alternative to the above, for Class 5 buildings the project team may use the empirical model of lift energy consumption. The Reference Project shall use the following inputs, consistent with Table 66

- Lift car mass: heavy;
- Lift drive type: variable voltage variable frequency AC (VVVFAC);
- Regenerative braking: none; and
- All other inputs: as per the Proposed Project.

Note that this method is based on correlation against an empirical dataset which includes office buildings only. It cannot be used for other building types, or where any lift within a building serves independent Class 5 and other usages, under any circumstances.

Where the project team considers the methodologies presented do not adequately calculate the improvement due to the Proposed Project lift design, they may submit a technical question proposing an alternative methodology. This may include lift simulation travel analysis. Where this is the case, the technical question must demonstrate the suitability of the lift call profiles to be used in the simulation with respect to the actual building usage, and the Reference Project simulation must be based on the lift system specified in Table 66.

13.5.4 Reference Project Appliances

For Class 2 buildings, appliances shall be included in the building total energy consumption. The performance standard to be used in the Reference Project is as follows:

Table 68: Reference Project appliance energy ratings

Item	Reference Specification	Reference Performance	Maximum Available Rating (note 1)	Normalised Energy Consumption (note 3)
Refrigerator/freezer	Group: 5T Fresh food: 250 L Freezer: 100 L	1.5-star below maximum available star rating	4-star	436 kWh/annum (2.5-star)
Dish washer	Place settings: 12	1.5-star below maximum available star rating	4.5-star	282 kWh/annum (3.0-star)
Clothes washer (note 2)	Load: 7 kg	1.5-star below maximum available star rating	5-star	367 kWh/annum (3.5-star)
Clothes dryer	Load: 6 kg	1.5-star below maximum available star rating	6-star	200 kWh/annum (4.5-star)

Notes:

1: Based on energy performance reported at www.energyrating.gov.au; project teams shall amend the reference project parameters as required according to the maximum available rating at the time of documentation.

2: Based on warm-wash cycle energy consumption.

3: Refer to E3, 2010 or relevant Australian Standards for equations used to calculate normalised energy consumption.

13.6 Energy Consumption Adjustment Factors

13.6.1 Car Park and Loading Dock Atmospheric Contaminant Control Systems

The following energy consumption adjustment factors apply to the installation of atmospheric contaminant monitoring systems and associated variable-speed fan control in car parks and loading docks. The adjustment factors provided in Table 70 are used to establish the adjusted full-load absorbed fan power as follows:

$$P_{fan,adj} = P_{fan} \times F_{adj}$$

Where $P_{fan,adj}$ is the adjusted full-load absorbed fan power (kW), P_{fan} is the absorbed fan power at the specified operating duty point (kW), and F_{adj} is the adjustment factor for atmospheric contaminant monitoring and variable speed fan control from Table 70.

The adjusted absorbed fan power is then used with the appropriate car park/loading dock HVAC profile to establish the annual energy use of the Proposed Project.

Table 69: Adjustment factor for atmospheric contaminant monitoring and variable-speed fan control

Requirement for Adjustment Factor	Adjustment Factor
Car park and/or loading dock mechanical ventilation fans that include variable-speed drives on supply and exhaust fans (as applicable) controlled by an atmospheric contaminant monitoring system in accordance with AS1668.2:2013	0.7

Where a project contains multiple physically separate car parks and/or loading docks, the adjustment factor must be applied individually to each area with a qualifying atmospheric contaminant monitoring and variable-speed fan control system.

13.6.2 Automatic Lighting Controls

The adjustment factors are used to establish an adjusted illumination power density for the Proposed Project as follows:

$$LPD_{prop,adj} = LPD_{prop} \times F_{adj}$$

Where $LPD_{prop,adj}$ is the adjusted proposed lighting power density (W/m²), LPD_{prop} is the nominal proposed lighting power density (W/m²), and F_{adj} is the adjustment factor for the proposed automatic lighting control system, as detailed in Table 71.

The adjustment factors can only be applied to luminaires controlled by the control system, not to the entire space.

Where more than one illumination power density adjustment factor applies to an area, they are to be combined using the following formula:

$$F_{adj} = F_{adj,A} \times \left(F_{adj,B} + \frac{1 - F_{adj,B}}{2}\right)$$

Where $F_{adj,A}$ is the lowest of the applicable lighting power density adjustment factors, and $F_{adj,B}$ is the second lowest of the applicable lighting power density adjustment factors. Note that if addressable lighting control is included, the fixed increment should be subtracted *after* the above calculation.

The adjusted proposed lighting power density is then used with the standard lighting profile for the space type (from Section 13.3) to establish the annual lighting energy use of the Proposed Project.

If your project includes automatic lighting controls that are not included here, approval to use specific alternative adjustment factors is required from the NZGBC. The project team may submit a technical question describing how they propose to apply adjustments for the specific control features and how the improvements have been assessed.

Table 70: Automatic lighting control adjustment factors

Item	Requirement for the use of the Adjustment Factor		Adjustment Factor
	Space type	Limitations	
Motion detector in accordance with NCC Part J6 (2013)	All spaces within a building except for 'industrial spaces' and car parks	Where an area of 200 m² or less is switched or dimmed as a block by one or more detectors.	0.9 (note 1)
	For 'industrial spaces'	Where the maximum area switched or dimmed as a block by one or more detectors is the area of the space divided by 10, or 2000 m², whichever is smaller. The minimum required block size is 200 m².	0.9 (note 1)
	All spaces within a building except for car parks	Where up to and including 6 lights are switched or dimmed as a block by one or more detectors.	0.7 (note 1)
		Where up to and including 2 lights are switched or dimmed as a block by one or more detectors.	0.55 (note 1)
	Car parks	Where an area of a car park of less than 500 m² is switched or dimmed as a block by one or more detectors.	0.7 (note 1)
Fixed dimming (note 4)	All	Lighting is controlled by fixed dimmers that reduce the overall lighting level and the power consumption of the lighting.	% of full power to which the dimmer is set
Daylight sensor and dynamic lighting control in accordance with NCC (2013) Specification J6 – dimming or stepped switching of lights adjacent to windows and/or roof lights	All	(a) Lights within the space adjacent to windows other than roof lights for a distance from the window equal to the floor-to-window-head height.	0.75 (notes 2 and 3)
		(b) Where the total area of roof lights is less than 10% of the floor area, but greater than 5%.	0.8 (notes 2 and 3)
		(c) Where the total area of roof lights is 10% or more of the floor area	0.75 (notes 2 and 3)
		For spaces other than those described under (a), (b) and (c), where lighting is controlled by dynamic dimming (note 5)	0.95 (notes 2 and 3)
Addressable lighting control system	All	Where an individually addressable system is installed, the adjustment factor can be further reduced by subtraction of an additional fixed increment.	additional fixed increment of 0.05

Notes:

1: Where luminaires are not switched off, but are only dimmed, the following equation must be used to determine the modified adjustment factor applicable to these luminaires:

$$F_{adj,dimmed} = F_{adj,switched} + \left(P_{dimmed} \times F_{adj,switched}\right)$$

Where $F_{adj,dimmed}$ is the adjustment factor to be applied to dimmed luminaires, $F_{adj,switched}$ is the adjustment factor applicable to switched luminaires (as per this table), and P_{dimmed} is the proportion of full-load power to which the luminaire input reduces when it is dimmed.

2: These adjustment factors do not apply to tungsten halogen or other incandescent sources.

3: These adjustment factors are conservative. If the design team believes that increased benefit will be realised, then the control operation should be modelled in accordance with Section 6.4.

The benefits of automatic controls can also be demonstrated by proposing modifications to the lighting schedules to be used. Such modified lighting schedules need to be approved by the NZGBC through the standard technical question process before being used in the modelling process.

4: Fixed dimming is the control through control gear adjustment or lighting control software of the maximum luminaire light output that cannot be adjusted by the space user.

5: Dynamic dimming is the automatic and continuous control of the luminaire light output in response to the signal from a photoelectric cell to compensate for the availability of natural light.

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