Green Star - Public Building

Greenhouse Gas Emissions Calculator Guide

Date Issued: May 2013

CHANGELOG

Version	Release Date	Description of Changes
1.0	June 2009	Green Star – Healthcare v1 Release
2.0	May 2009	Green Star – Industrial v1 Release (Not applicable to Green Star – Healthcare v1)
3.0	August 2010	Draft Release for Green Star – Custom PILOT projects
3.1	October 2010	Draft Release for Green Star – Public Building PILOT projects
4.0	April 2011	Combined Green Star – Custom Greenhouse Gas Emissions Guide
5.0	May 2013	Green Star – Public Building v1 release

Table of Contents

Glossary

Benchmark Building: A hypothetical building that is responsible for 10% less greenhouse gas emissions than the Standard Practice Building. Points are awarded where the emissions from the Proposed Building are lower than the Benchmark Building's emissions.

Carbon dioxide equivalent (kgCO2-e): Carbon dioxide equivalent 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 (US EPA, 2009). For the purposes of the Green Star tools, carbon dioxide equivalents are expressed as "kilograms of carbon dioxide equivalents (kgCO_2-e)."

Greenhouse gas emissions factor (kgCO_2-e/kWh, or kgCO_2-e/MJ): 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.

Global Warming Potential (GWP): 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 (US EPA, 2009). For the purposed of Green Star, 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.

Proposed Building: The building, as designed and modelled by the project team.

Scope 1, 2 & 3 Emissions: Scope 1 emissions are 'direct' greenhouse gas emissions (due to activities within an organisation's boundary). Scopes 2 and 3 are 'indirect' greenhouse gas emissions (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 which occur due to the combustion of fuel on-site, such as the combustion of gas in a building's hot water boiler or cogeneration system, and the leakage of synthetic gases from refrigeration plant. Scope 2 emissions are those which result from the generation of electricity used by the building. Scope 3 emissions include the indirect emissions that result from the processing and transportation of fuels used within the building. See Chapter 1 of the National Greenhouse Accounts (DCC, 2010) for further information.

Standard Practice Building: A hypothetical building based predominantly on the BCA Section J Deemed-to-Satisfy provisions.

Introduction

The Energy Conditional Requirement and Ene-1: Greenhouse Gas Emissions encourage and recognise reductions in greenhouse gas emissions associated with modelled operational energy consumption, fuel choice, and on-site energy generation. These credits are assessed by comparing the estimated greenhouse gas emissions of the 'Proposed Building' with that of a ‘Standard Practice Building’. This document provides guidance on how to model the inputs required by the GHG Emissions Calculator and interpret the results.

The Energy Conditional Requirement is met when the greenhouse gas emissions from the Proposed Building are better than the benchmark. Up to 20 points in Ene-1: Greenhouse Gas Emissions are awarded for further reductions; One point for every 5% improvement, with the maximum number points (20) awarded where no greenhouse gas emissions are emitted from the building during operation.

The method is based on the JV3 verification method found in Section J of the Building Code of Australia (BCA). For items in the building where there are no energy efficiency requirements in the BCA, performance representative of standard practice of a similar building in Australia is used and detailed in this guide.

NOTE:

It should be noted that the estimates of energy consumption and greenhouse gas emissions from these calculators should only be used for claiming points under Green Star - Public Building. The estimates are not predictions of actual energy consumption or greenhouse gas emission. This is because:

- Project teams are required to use a number of standard assumptions when calculating energy use, such as standard occupancy patterns and weather conditions. This allows for a level playing field of comparison against the benchmark building. In reality, occupancy patterns, weather conditions and the effectiveness of how the building is operated and maintained will vary. This will affect the energy consumed. A number of these issues, are, however considered in other credits.
- There are additional energy uses which are not captured by this methodology such as the occupant consumer goods. Therefore the actual energy consumed will differ from the estimations made for this credit. The energy consumption from a number of these items are considered in other credits.
- The Green Star –Greenhouse Gas Emissions calculator is a simplified approach to estimating greenhouse gas emissions.

In addition, please note that benchmark figures presented have been rounded so discrepancies may occur between sums of the component items and totals.

The Energy category

The assessment of the Energy Conditional Requirement and Ene-1: Greenhouse Gas Emissions is based on a comparison of the modelled greenhouse gas emissions from the Proposed Building during operation with that of a Standard Practice Building.

There are two stages to estimating the greenhouse gas emissions estimates for the Proposed and Standard Practice Buildings.

1. A simulation of the building's operational energy consumption from operating the building and any on-site energy generation is estimated through dynamic simulation. This energy consumption and generation is then entered into the Green Star – GHG Emissions Calculator which estimates the greenhouse gas emissions resulting from the operation of the building.
2. An estimate of the leakage of synthetic gases (such as refrigerants) with global warming potential is estimated from the systems in the Proposed Building. Unless indicated, the information for synthetic gases is for information purposes only, and does not affect the final rating.

The resultant compliance with the Conditional Requirement and number of points for Ene-1 are then calculated by the Green Star – Greenhouse Gas Emissions Calculator based on the information provided.

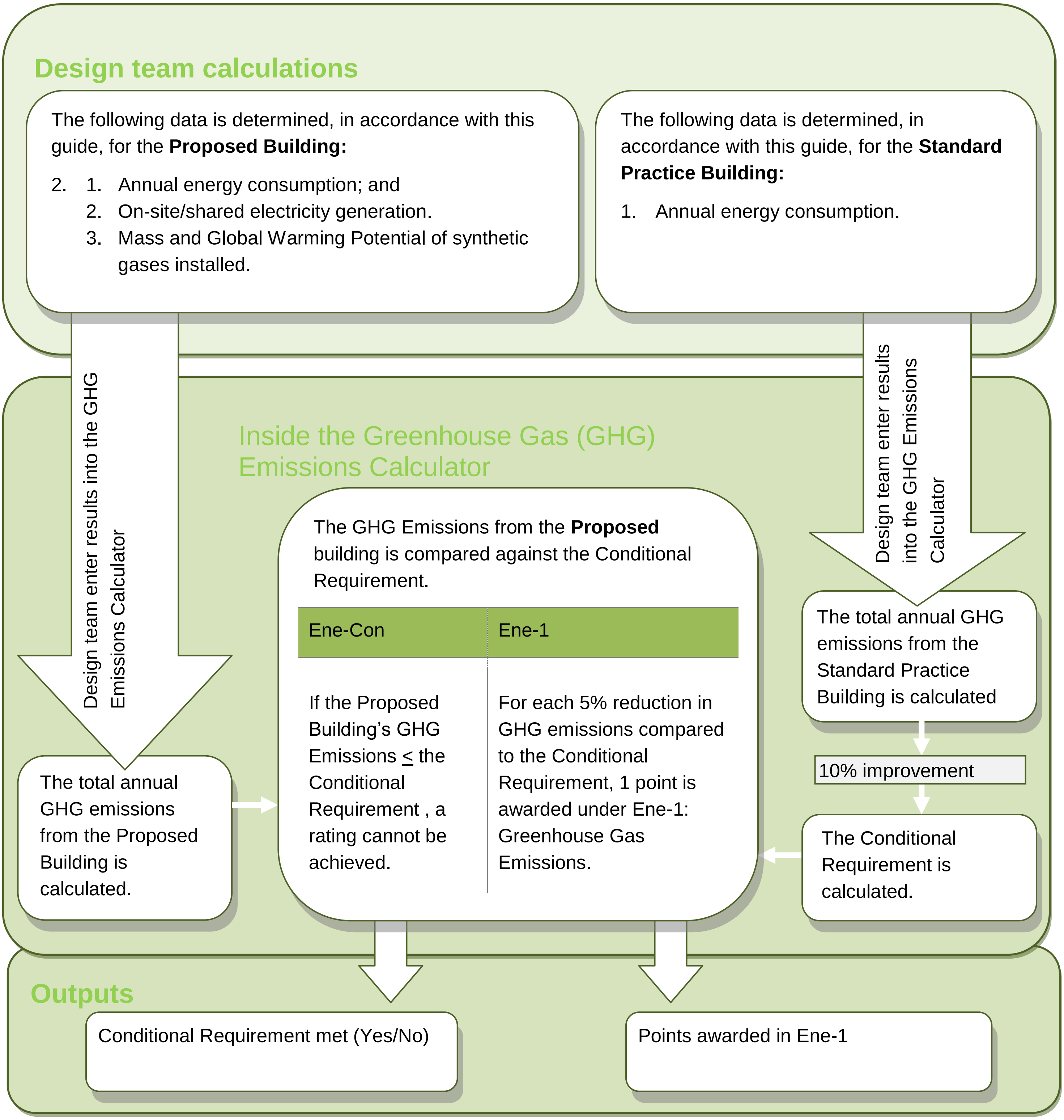
Both the Ene-Conditional Requirement and the Ene-1 'Greenhouse Gas Emissions' credits contain additional information on the details of the conditional requirement. The guidance in the credits supersede the guidance in these guides unless indicated otherwise.

THE ENERGY CONDITIONAL REQUIREMENT

The Energy Conditional Requirement is calculated by comparing the proposed building against a 10% improvement over the legislated performance standard under section J of the Building Code of Australia applicable at the time of Development Approval. Therefore, the proposed building's greenhouse gas emissions must be 10% lower than a Standard Practice Building as defined in section JV3 of the BCA.

HOW POINTS ARE AWARDED UNDER ENE-1: GREENHOUSE GAS EMISSIONS

Points are awarded based on modelled performance. In this credit, the project's modelled emissions are compared against a benchmark, and 1 point is awarded for every 5% improvement over it, for a maximum of 20 points. For this rating tool, the benchmark is the Energy - Conditional Requirement.



The following data is determined, in accordance with this guide, for the **Proposed Building:**

2. 1. Annual energy consumption; and
   2. On-site/shared electricity generation.
   3. Mass and Global Warming Potential of synthetic gases installed.

The following data is determined, in accordance with this guide, for the **Standard Practice Building:**

1. Annual energy consumption.

The total annual GHG emissions from the Proposed Building is calculated.

The GHG Emissions from the **Proposed** building is compared against the Conditional Requirement.

Ene-Con	Ene-1
If the Proposed Building's GHG Emissions ≤ the Conditional Requirement , a rating cannot be achieved.	For each 5% reduction in GHG emissions compared to the Conditional Requirement, 1 point is awarded under Ene-1: Greenhouse Gas Emissions.

The total annual GHG emissions from the Standard Practice Building is calculated

The Conditional Requirement is calculated.

Conditional Requirement met (Yes/No)

Points awarded in Ene-1

Figure 1 The process for determining the Energy Conditional Requirement and the number of points awarded in Ene-1: Greenhouse Gas Emissions for non-residential spaces.

How to use this guide

This guide is divided into two parts. Part A provides guidance for this rating tool. Appendices are then listed that provide supporting information to this guide. This guide must be used in conjunction with the Green Star – Public Building Spreadsheet (referred to in this document as *spreadsheet*)

PART A: CALCULATING GREENHOUSE GAS EMISSIONS

Guidance on how to undertake the dynamic energy simulations of the Proposed and Standard Practice Buildings, and how to collect the data required for estimating leakage of synthetic gases is provided in:

- Chapter 1 Requirements for energy simulation
- Chapter 2:Data requirements for synthetic gas leakage

Guidance on how to enter data into the Green Star – Greenhouse Gas Emissions Calculator and interpret the results is provided in Chapter 3: The Greenhouse Gas Emissions Calculator;

Details of the information required to be included in the Greenhouse Gas Emissions Modelling Report are included in Chapter 4: Greenhouse Gas Emissions Modelling Report .

PART C: APPENDICES

Details the appendices referenced in the energy simulation methodology.

SUPPLEMENTAL DOCUMENTATION

In addition, the Green Star - Public Building Benchmark Document details the benchmarks use to calculate the greenhouse gas emissions for the standard practice building.

PART A:
Calculating Greenhouse Gas Emissions

1. Requirements for energy simulation

This chapter provides details on how each element of the Proposed and Standard Practice Buildings should be modelled and what simulation software should be used to do so. The modelling methodology described in this document is based on the modelling methodology that can be used to demonstrate compliance with Section J of the Building Code of Australia (BCA); the JV3 Verification Methodology.

Where the GBCA received feedback that the JV3 Verification Methodology was not appropriate for a building type, or where particular measure or item were not being assessed or recognised by the BCA, the methodology has been altered.

Notes:

1. Where the BCA is referenced, the version applicable to the project is the BCA relevant to the development application of the project. When quoted, the clause numbers are from BCA 2009 Volume One
2. The guidance in this document applies to all tools. Where specific requirements apply, or do not apply, to a specific tool, this shall be explicitly noted in the guide.

Simulation software requirements

As with the BCA Specification JV, the energy consumption from the Proposed and Standard Practice Building 'must be calculated using a thermal calculation method that complies with the ABCB Protocol for Energy Analysis Software 2006.1' (BCA Specification JV, clause 2(f)).

Overview of the simulation of the Proposed and Standard Practice Building performance

As described in the BCA JV3 Verification Methodology, the Proposed Building and Standard Practice Building must be calculated with the same calculation method (as defined above); physical model; internal heat gains; occupancy and operational profiles; servicing requirements; HVAC zoning; and in the same location with the same environmental conditions.

STANDARD PRACTICE BUILDING

The annual energy consumption from the Standard Practice Building must be modelled in accordance with the BCA JV3 verification methodology with some exceptions. For the Standard Practice building, the building envelope performance, HVAC plant performance and lighting lamp power or illumination power density must be based on the BCA Deemed-to-Satisfy criteria. The exceptions to using the JV3 verification methodology for the Standard Practice Building include the following:

- The Standard Practice Building HVAC system type and configuration must be as described in Appendix BDefinition of the Standard Practice Building HVAC System. However, as noted above, the HVAC plant performance parameters must be in accordance with BCA;
- Where relevant, the energy consumption from external lighting, and lifts are to be included, in accordance with the efficiencies given in this document;
- Where relevant, the thermal performance of the building fabric and plant efficiencies of cold rooms/freezer rooms are to be as defined in this document.

PROPOSED BUILDING

The annual energy consumption from the Proposed Building must be modelled in accordance with the BCA Section JV3 Verification Method with the following variations:

- The climate file (see Table 1);
- The HVAC heat loads, and the occupancy and operational profiles (see HVAC design parameters and occupancy and operational profiles)[1];
- The energy consumption from lifts is included (see Table 1);
- The percentage of electricity generated on–site from sources that do not emit greenhouse gases (such as solar and wind) can be included fully.
- The energy consumption from external lighting is included.
- The energy savings achieved by lighting zoning and automatic controls are estimated and included in all tools.

All parameters used in the modelling of the Proposed Building should be consistent with the design documents.

---

[1] Please note, the occupancy, lighting, and equipment heat gains provided within this guide are for modelling purposes only. These figures are not intended to be used in the design and sizing of systems. The design and sizing of systems must be done in accordance with the project's requirements. If the project team wishes to use alternative profiles, they must submit a Credit Interpretation Request (CIR). Please note that if alternative profiles are approved, the same profiles must still be used for the Proposed and Reference Buildings.

Simulation guidelines for each parameter for the Proposed and Standard Practice Building

Table 1: Modelling requirements for calculating the Proposed and Standard Practice Building energy consumption

No.		Proposed Building modelling requirements	Standard Practice Building modelling requirements
1	Thermal calculation method	As *BCA Specification JV, clause 2.(f)*, a thermal calculation method that complies with the ABCB Protocol for Energy Analysis Software 2006.1'	As Proposed Building model. (as BCA Section J, JV3 (b)(ii)(A))
2	Location (selection of climate file)	One of the following three options: - A Test Reference Year (TRY) if the building location is within 50km of a TRY location; or - In the absence of local TRY weather data, an actual year of recorded weather data from a location within 50km of the building location; or - In the absence of TRY or actual weather data within 50km, interpolated data based upon 3 points within 250km of the building location. Please contact the Green Building Council of Australia for approval of alternative climate files if the project cannot comply with any of the above options.	As Proposed Building model. (as BCA Section J, JV3 (b) (ii) (B))
3	Adjacent structures and features	As *BCA Section J, JV3 (b) (ii) (C))*, overshadowing from the surrounding environment must be taken into account in the model.	As Proposed Building model. (as BCA Section J, JV3 (b) (ii) (C))
4	Environmental conditions	As BCA Section J, JV3 (b) (ii) (D))	As Proposed Building model. (as BCA Section J, JV3 (b) (ii) (D))
5	Orientation	The representation of the Proposed Building orientation shall be consistent with the design documents.	As Proposed Building model. (as BCA Section J, JV3 (b) (ii) (E))
6	Geometric model	The representation of Proposed Building's geometry shall be consistent with the design documents.	As Proposed Building model. (as BCA Section J, JV3 (b) (ii) (F, G, H, I, J, K, L, M, N, O))

<table>
<tr><th>No.</th><th></th><th>Proposed Building modelling requirements</th><th>Standard Practice Building modelling requirements</th></tr>
<tr><td>7</td><td>Building envelope</td><td>The simulation of the Proposed Building envelope shall be consistent with the design documents.
Note: Manual fenestration shading devices such as blinds or shades shall not be modelled.</td><td>BCA Deemed-to-Satisfy provisions
(see BCA Section J, JV3 (b) (i) (A))<table><tr><td colspan="3">Exception: Where building integrated cold rooms/freezer rooms are present, the following thermal properties should be used for these areas:</td></tr><tr><td>Cold Store Walls</td><td>Concrete (100mm) / Insulation (90mm) / Cavity (50mm) / Internal Composite Panel (25mm)</td><td>U-Value: 0.24W°/m².K</td></tr></table></td></tr>
<tr><td>8</td><td>External surface Solar Absoptance</td><td>As specified within design documents; or, if unknown, 0.7, (<i>as BCA Section J, JV3 (b) (i) (B)</i>).</td><td>A solar absoptance of 0.7 shall be used for the Standard Practice Building <i>(as BCA Section J, JV3 (b) (i) (B))</i></td></tr>
<tr><td>9</td><td>HVAC zones</td><td>The simulation of the Proposed HVAC zones shall be consistent with the design documents.</td><td>As Proposed Building model.
(BCA Section J, JV3 (b) (ii) (T))</td></tr>
<tr><td>10</td><td>Heating Ventilation and Air Conditioning</td><td>The proposed HVAC system type and configuration must be modelled in accordance with BCA Specification JV, clause 2(a) with the exception of the HVAC Design Parameters given in Appendix A which supersede clauses <i>2(a)(i), 2(a)(ii), 2(a)(v) and 2(a)(vi).</i>
All ventilation only systems (e.g. in car parks, loading docks and warehouses) must be included in the energy model. Appendix A contains operational profiles which must be used for these system types.
Credit may be taken for installing atmospheric contaminant monitoring systems and variable speed drive (VSD) fans in car parks and loading docks by using the Adjustment Factor given in Appendix CEnergy Consumption Adjustment Factors.
[Continued next page]</td><td>The Standard Practice Building's HVAC system type and configuration must be as specified in Appendix BDefinition of the Standard Practice Building HVAC System
The system must be modelled in accordance with BCA Specification JV, clause 2 (a), with the exception of the HVAC design parameters given in Appendix A which supersede clauses <i>2(a)(i), 2(a)(ii), 2(a)(v) and 2(a)(vi).</i>
Those spaces in the proposed building 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) to the minimum requirements as per AS 1668.2 – 2002. The Standard Practice building's ventilation systems shall meet the maximum fan shaft power requirements of Section J5.
[Continued next page]</td></tr>
</table>

No.	Proposed Building modelling requirements	Standard Practice Building modelling requirements

[Continued from last page]

Where the Proposed or Standard Practice Building contains a VAV system, and where those supply fans have variable speed drives, their part-load performance characteristics shall be modeled using either Method 1 or Method 2 given below:
Method 1 – Part-Load Fan Power Data

Fan Part-Load Ratio	Fraction of Full-Load Power
0.00	0.00
0.10	0.03
0.20	0.07
0.30	0.13
0.40	0.21
0.50	0.30
0.60	0.41
0.70	0.54
0.80	0.68
0.90	0.83
1.00	1.00

Method 2 – Part-Load Fan Power Equation

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

Where:

P_{fan} = fraction of full-load fan power; and

PLR_{fan} = fan part-load ratio (current cfm/desiogn cfm)

(Clause G3.1.3.15 ASHRAE 90.1-2007 (SI) (ASHRAE, 2007) for further information on ASHRAE 09.1-2007, see footnote in Definition of the Standard Practice Building HVAC System)

No.		Proposed Building modelling requirements	Standard Practice Building modelling requirements
11	Refrigeration (cold rooms/freezer rooms)	The annual energy consumption for the proposed building's base building refrigeration systems (cold room/freezer rooms) must be modelled on the basis of the proposed refrigeration system with the daily profiles, heat gains and infiltration levels given in HVAC design parameters and occupancy and operational profiles. Note: Only refrigeration systems which condition low temperatures spaces constructed within the building need be modelled. Any refrigerated containers, display cabinets or refrigerators that are not permanently fixed to the building structure, are not to be modelled. These are classified as equipment.	The Standard Practice building's refrigeration systems must be modelled with the same design parameters (including temperature and humidity) as the proposed building, and with the same daily profiles, internal heat loads and infiltration levels used in modelling the proposed building, as given in HVAC design parameters and occupancy and operational profiles. The energy efficiency performance requirement of the Standard Practice building refrigeration system(s) shall be the minimum required by the Australian Government's Minimum Energy Performance Standard (MEPS), at the time of registration or later. The MEPS applicable at the time of the release of this guide are given in Australian Standard 4776.2:2008 (AS/NZS, 2008) 'Minimum energy performance standards (MEPS) minimum requirements for liquid-chilling packages', and are available to view on the Australian Government's Energy Rating website: http://www.energyrating.gov.au/chillers.html Where no MEPS exist at the time of registration or later, for a particular capacity, the performance requirement for the next capacity band must be assumed. (eg: for a liquid chilling package of less that 350kWR, the project team must refer to the MEPS for systems with a capacity of 350-499kWR). Alternatively, for industrial or complex facilities, project teams may choose to propose an alternative standard practice benchmark for refrideration equipment in cold rooms/ freezer rooms. The project team must submit a CIR justifying their methodology.

No.		Proposed Building modelling requirements	Standard Practice Building modelling requirements
12	Artificial internal lighting	The annual energy consumption from internal artificial lighting must be calculated on the basis of the proposed level of artificial lighting in the building with the daily profiles given in Appendix A. This includes any internal car park lighting. Credit may be taken for lighting zoning and automatic controls in addition to those required for minimum code compliance. See Appendix CEnergy Consumption Adjustment Factors	Maximum illumination power used in the Standard Practice building must be as specified in the *Deemed-to-Satisfy* Provisions with the following allowance for Room Size: Required lighting levels must be as the Proposed Building. (BCA Section J, JV3 (b) (ii) (R)). The same profiles must be used as are used in the proposed building (given in HVAC design parameters and occupancy and operational profiles). The Standard Practice Building's illumination power density can be increased by dividing it by the appropriate 'Room Size' illumination power density adjustment factor from Section J6.2 of the BCA. Note - the Standard Practice Building, is assumed to have no occupancy or daylight sensors; corridor timers; dimming systems; or dynamic lighting control devices in addition to what is required by the BCA (BCA Section J, JV3 (b) (i) (A & C)). Therefore no other adjustment factors can be applied to the Standard Practice Building.
13	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 HVAC design parameters and occupancy and operational profiles. All external lighting, except for emergency lighting, must be included in the proposed building energy consumption calculation (this includes landscape and decorative lighting). Minimum power density to be assumed where the proposed building's design lighting levels do not meet the requirements of AS1158.3.1: Where the proposed building design lighting levels do not meet the horizontal lighting lux requirements of AS1158.3.1, the power density used in the energy consumption	The annual energy consumption from the external lighting shall be calculated with the external lighting power density given in **Table 2** below, and the daily profiles given in Appendix A. The same external areas shall be illuminated in the Standard Practice building design as are in the proposed building design, excluding any landscape or decorative lighting. Emergency lighting shall also be excluded. To establish which standard practice power density should be used for a particular area, the lighting designer must identify the appropriate category from AS1158.3.1.

<table>
<tr><th>No.</th><th></th><th>Proposed Building modelling requirements</th><th>Standard Practice Building modelling requirements</th></tr>
<tr><td></td><td></td><td>calculation must be whichever is higher of:
• The proposed building power density; or
• The standard practice power density given in Table 2: Standard practice external lighting power densities for the appropriate AS1158.3.1 category.
(This ensures that providing poor lighting is not an energy saving measure which is rewarded in this credit)
Credit may be taken for automatic controls in addition to those required for minimum code compliance. See Appendix CEnergy Consumption Adjustment Factors</td><td>Table 2: Standard practice external lighting power densities
<table>
<tr><th>Category</th><th>Power Density</th></tr>
<tr><td>P1 (Note 1)</td><td>7.1 watts/m</td></tr>
<tr><td>P2 (Note 1)</td><td>4.3 watts/m</td></tr>
<tr><td>P3 (Note 1)</td><td>3.5 watts/m</td></tr>
<tr><td>P4 (Note 1)</td><td>2.6 watts/m</td></tr>
<tr><td>P5 (Note 1)</td><td>2.2 watts/m</td></tr>
<tr><td>P6</td><td>2.1 watts / m^2</td></tr>
<tr><td>P7</td><td>1.4 watts / m^2</td></tr>
<tr><td>P8</td><td>0.8 watts / m^2</td></tr>
<tr><td>P9</td><td>Match Adjacent category</td></tr>
<tr><td>P10</td><td>1.7 watts / m^2</td></tr>
<tr><td>P11a</td><td>1.5 watts / m2</td></tr>
<tr><td>P11b</td><td>0.6 watts / m2</td></tr>
<tr><td>P11c</td><td>0.2 watts / m2</td></tr>
<tr><td>P12</td><td>9.0 watts / m2</td></tr>
</table>
NOTE 1: Based on path widths up to 6 metres. For larger path widths greater than 6 metres multiply power density by number of 6 metre widths or part thereof. Eg. if path is 8 metres is 1.33 widths therefore multiply by 2.</td></tr>
</table>

No.		Proposed Building modelling requirements	Standard Practice Building modelling requirements
14	Domestic hot water systems It is necessary to complete the **Potable Water Calculator**, within the Green Star – Rating Tool, before the energy consumption from the Proposed and Standard Practice Building's domestic hot water system can be calculated.	The domestic hot water usage of the Proposed Building is calculated by the Green Star - Potable Water Calculator. The domestic hot water usage of the Proposed Building depends on the water efficiency of the building's 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 building. Solar hot water and heat pump boosted systems should be evaluated using the 'Green Star Solar Hot Water and Heat Pump Booster Energy Calculation Methodology' which can be downloaded from the GBCA website, www.gbca.org.au.	As with the Proposed Building, the domestic hot water usage of the Standard Practice Building is calculated by the Potable Water Calculator. The Standard Practice Building's hot water system is a gas water heater with a thermal efficiency as given in Table J5.4b Minimum Thermal Efficiency of a Water Heater, of the BCA Section J.

Once the Potable Water Calculator is complete, the annual domestic hot water usage of the Proposed and Standard Practice Buildings is displayed at the top of the Potable Water Calculator as shown in Figure 2 below.

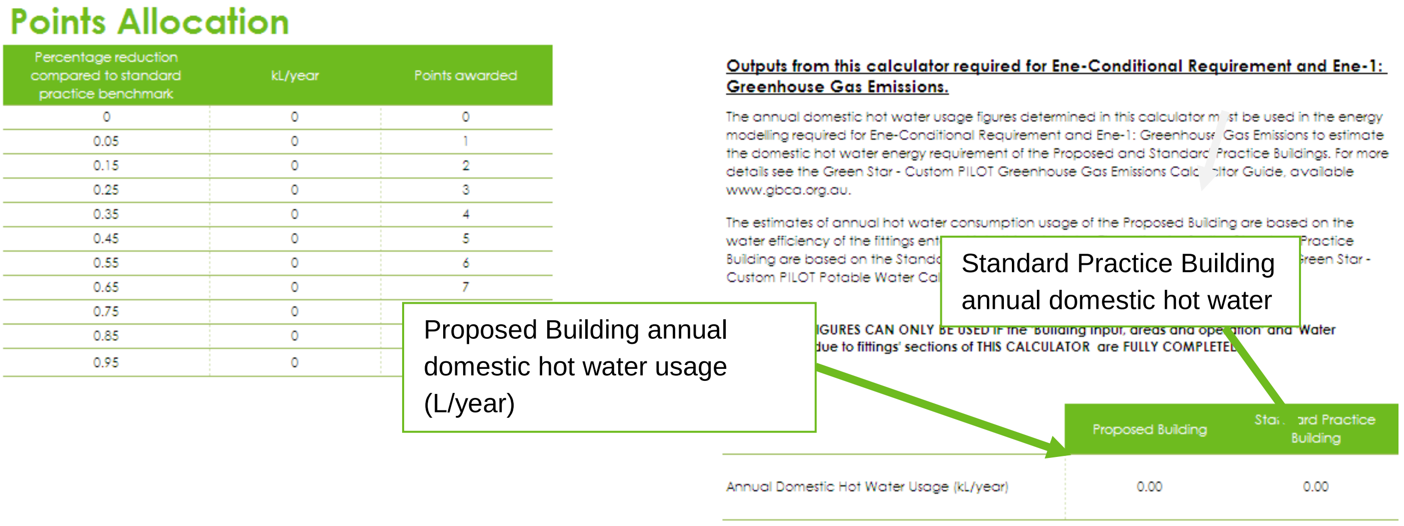


Figure 2: The Proposed and Standard Practice Building annual domestic hot water usage in the Potable Water Calculator.

Points Allocation

Percentage reduction compared to standard practice benchmark	kL/year	Points awarded
0	0	0
0.05	0	1
0.15	0	2
0.25	0	3
0.35	0	4
0.45	0	5
0.55	0	6
0.65	0	7
0.75	0	[illegible]
0.85	0	[illegible]
0.95	0	[illegible]

Outputs from this calculator required for Ene-Conditional Requirement and Ene-1: Greenhouse Gas Emissions.

The annual domestic hot water usage figures determined in this calculator m st be used in the energy modelling required for Ene-Conditional Requirement and Ene-1: Greenhous Gas Emissions to estimate the domestic hot water energy requirement of the Proposed and Standard Practice Buildings. For more details see the Green Star - Custom PILOT Greenhouse Gas Emissions Calc ltor Guide, available www.gbca.org.au.

The estimates of annual hot water consumption usage of the Proposed Building are based on the water efficiency of the fittings ent … Practice Building are based on the Standa … Green Star - Custom PILOT Potable Water Cal …

… IGURES CAN ONLY BE USED IF the 'Building input, areas and ope ation' and 'Water … due to fittings' sections of THIS CALCULATOR are FULLY COMPLETED

	Proposed Building	Standard Practice Building
Annual Domestic Hot Water Usage (kL/year)	0.00	0.00

Proposed Building annual domestic hot water usage (L/year)

Standard Practice Building annual domestic hot water

No.		Proposed Building modelling requirements	Standard Practice Building modelling requirements
15	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 building. The modelling methodology to be used must be proposed by the design team in the form of a CIR. Where a diesel generator is installed, it must be assumed that standard diesel, rather that any alternative liquid fuel, is used, unless the generator has been modified to accept the alternative fuel only.	None
16	Lifts	Modelled using the modified Draft ISO standard calculation methodology detailed in Appendix CEnergy Consumption Adjustment Factors	Modelled using the modified Draft ISO standard calculation methodology detailed in Appendix CEnergy Consumption Adjustment Factors
17	Other energy consumption	Any other energy consumed on site for base building facilities such as a water recycling treatment plant, should be calculated by the design team and included. All assumptions used in the calculation must be provided in the documentation and justified.	None
18	Small power and process loads	The energy consumed by small power or process equipment directly, is not included in the assessment. This energy consumption is related to the function of the building rather than the physical attributes of the building fabric and services which is being assessed in this credit. Please note however, that internal heat loads resulting from equipment use must be included in the simulation of the HVAC energy consumption as detailed in Appendix A.	As Proposed Building model.
19	Swimming Pool	See Appendix H.	As Proposed Building model.

2. Data requirements for synthetic gas leakage

It is a requirement that all Green Star - Public Building projects complete this section of the Greenhouse Gas Emissions Calculator. The information provided is for information purposes only. This information will not impact your score.

To better assess the greenhouse gas emissions of a building, the global warming impacts resulting from synthetic gas leakage are taken into account when calculating the total reduction of greenhouse gas emissions of a building compared to standard practice. The synthetic gases being considered are Hydrofluorocarbons (HFC) commonly used as refrigerants in air-conditioning and refrigeration systems and Sulphur Hexafluoride (SF_6), which can be used in switchgear and circuit breaker applications.

For each piece of equipment which contains an HFC refrigerant or SF_6 that is to be installed in the building, the following information is required:

- The type of refrigerant;
- The mass of refrigerant (the stated capacity of the equipment according to the manufacturer's nameplate); and
- The operating conditions for each system (as selected from the calculator dropdown)[2]

This information is required to be entered into the Greenhouse Gas Emissions Calculator separately for Commercial air conditioning—chillers, Industrial refrigeration including food processing and cold storage, and Gas insulated switchgear and circuit breaker applications

The calculator automatically selects the Global Warming Potential of each selected refrigerant. Where a refrigerant is not present in the list, the project team can manually input the GWP100 for the selected refrigerant. This GWP100 must be justified at the time of submission. If the refrigerant has not yet been selected, the refrigerant R134 must be used.

For information on the methodology involved, see Appendix F Leakage of synthetic gases.

---

[2] See AIRAH, 2003. Where the operating conditions for the system do not match the available operating conditions, the closest condition must be selected, or, alternatively, a CIR can be submitted to request and alternative operating condition.

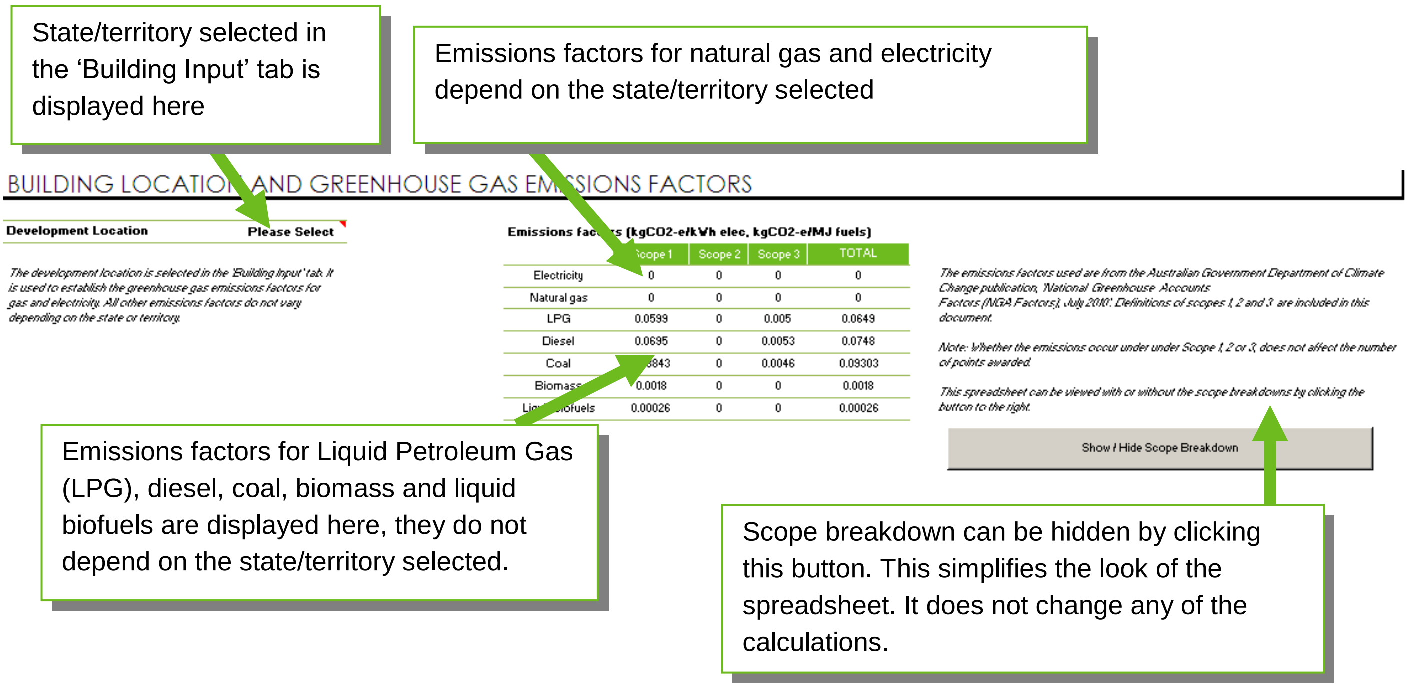
3. The Greenhouse Gas Emissions Calculator

The Greenhouse Gas Emissions Calculator in the Green Star – Calculators Spreadsheet has four sections. This chapter explains the information presented and inputs required in each section.

‘Greenhouse gas emissions factors’

The following section is for information purposes only, and does not require direct input from the project team. This section displays the emissions factors used for the project’s state/territory, which was entered in the Building Input tab in the Calculators Spreadsheet. See Appendix E Greenhouse gas emissions factors for more information.

Throughout each section, the calculator can show the greenhouse gas emissions broken down into Scope 1, 2 and 3 (see Glossary). Whether the emissions occur under Scope 1 2 or 3 does not alter the results of the calculator. The spreadsheet can be viewed with or without the breakdown by scope by pressing the ‘Hide emissions breakdown by scope’ or ‘Show emissions breakdown by scope’ buttons.



State/territory selected in the ‘Building Input’ tab is displayed here

Emissions factors for natural gas and electricity depend on the state/territory selected

BUILDING LOCATIO AND GREENHOUSE GAS EM SSIONS FACTORS

Development Location **Please Select**

The development location is selected in the 'Building Input' tab. It is used to establish the greenhouse gas emissions factors for gas and electricity. All other emissions factors do not vary depending on the state or territory.

Emissions fac s (kgCO2-e/kWh elec, kgCO2-e/MJ fuels)

	cope 1	Scope 2	Scope 3	TOTAL
Electricity	0	0	0	0
Natural gas	0	0	0	0
LPG	0.0599	0	0.005	0.0649
Diesel	0.0695	0	0.0053	0.0748
Coal	843	0	0.0046	0.09303
Biomass	0.0018	0	0	0.0018
Lic iofuels	0.00026	0	0	0.00026

The emissions factors used are from the Australian Government Department of Climate Change publication, 'National Greenhouse Accounts Factors (NGA Factors), July 2010'. Definitions of scopes 1, 2 and 3 are included in this document.

Note: Whether the emissions occur under under Scope 1, 2 or 3, does not affect the number of points awarded.

This spreadsheet can be viewed with or without the scope breakdowns by clicking the button to the right.

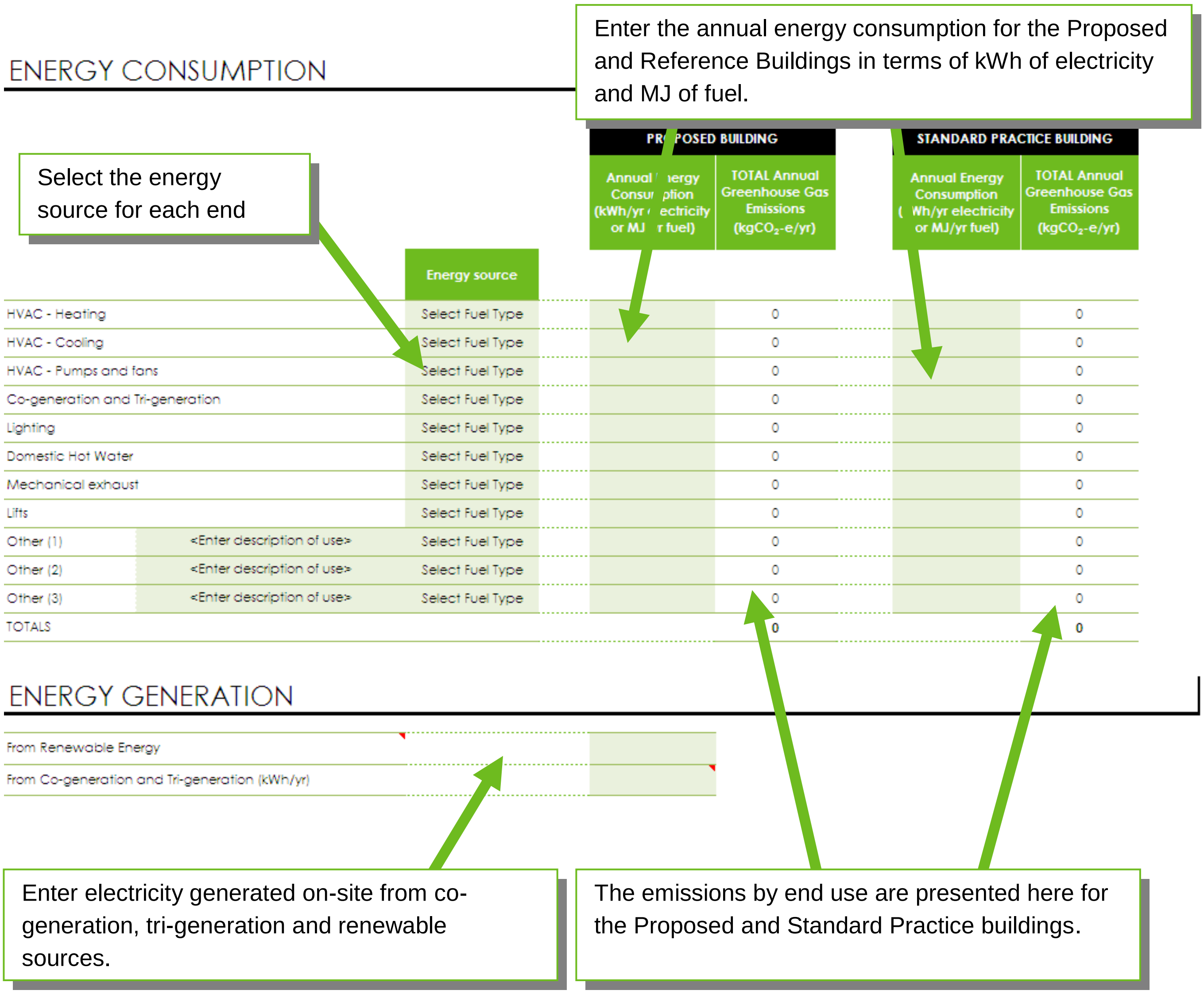
Emissions factors for Liquid Petroleum Gas (LPG), diesel, coal, biomass and liquid biofuels are displayed here, they do not depend on the state/territory selected.

Scope breakdown can be hidden by clicking this button. This simplifies the look of the spreadsheet. It does not change any of the calculations.

For purposes of clarity, the following sections are presented in this guide without the breakdown by scope.

‘Energy consumption and generation’

The following section requires input by the project team. In this section, the annual energy consumption and generation from the Proposed Building and the Standard Practice Building, and the energy source from each must be entered into the calculator, as shown below.



Enter the annual energy consumption for the Proposed and Reference Buildings in terms of kWh of electricity and MJ of fuel.

Select the energy source for each end

Enter electricity generated on-site from co-generation, tri-generation and renewable sources.

The emissions by end use are presented here for the Proposed and Standard Practice buildings.

ENERGY CONSUMPTION

			PROPOSED BUILDING		STANDARD PRACTICE BUILDING	
		Energy source	Annual Energy Consumption (kWh/yr electricity or MJ/yr fuel)	TOTAL Annual Greenhouse Gas Emissions ($kgCO_2$-e/yr)	Annual Energy Consumption (kWh/yr electricity or MJ/yr fuel)	TOTAL Annual Greenhouse Gas Emissions ($kgCO_2$-e/yr)
HVAC - Heating		Select Fuel Type		0		0
HVAC - Cooling		Select Fuel Type		0		0
HVAC - Pumps and fans		Select Fuel Type		0		0
Co-generation and Tri-generation		Select Fuel Type		0		0
Lighting		Select Fuel Type		0		0
Domestic Hot Water		Select Fuel Type		0		0
Mechanical exhaust		Select Fuel Type		0		0
Lifts		Select Fuel Type		0		0
Other (1)	<Enter description of use>	Select Fuel Type		0		0
Other (2)	<Enter description of use>	Select Fuel Type		0		0
Other (3)	<Enter description of use>	Select Fuel Type		0		0
TOTALS				**0**		**0**

ENERGY GENERATION

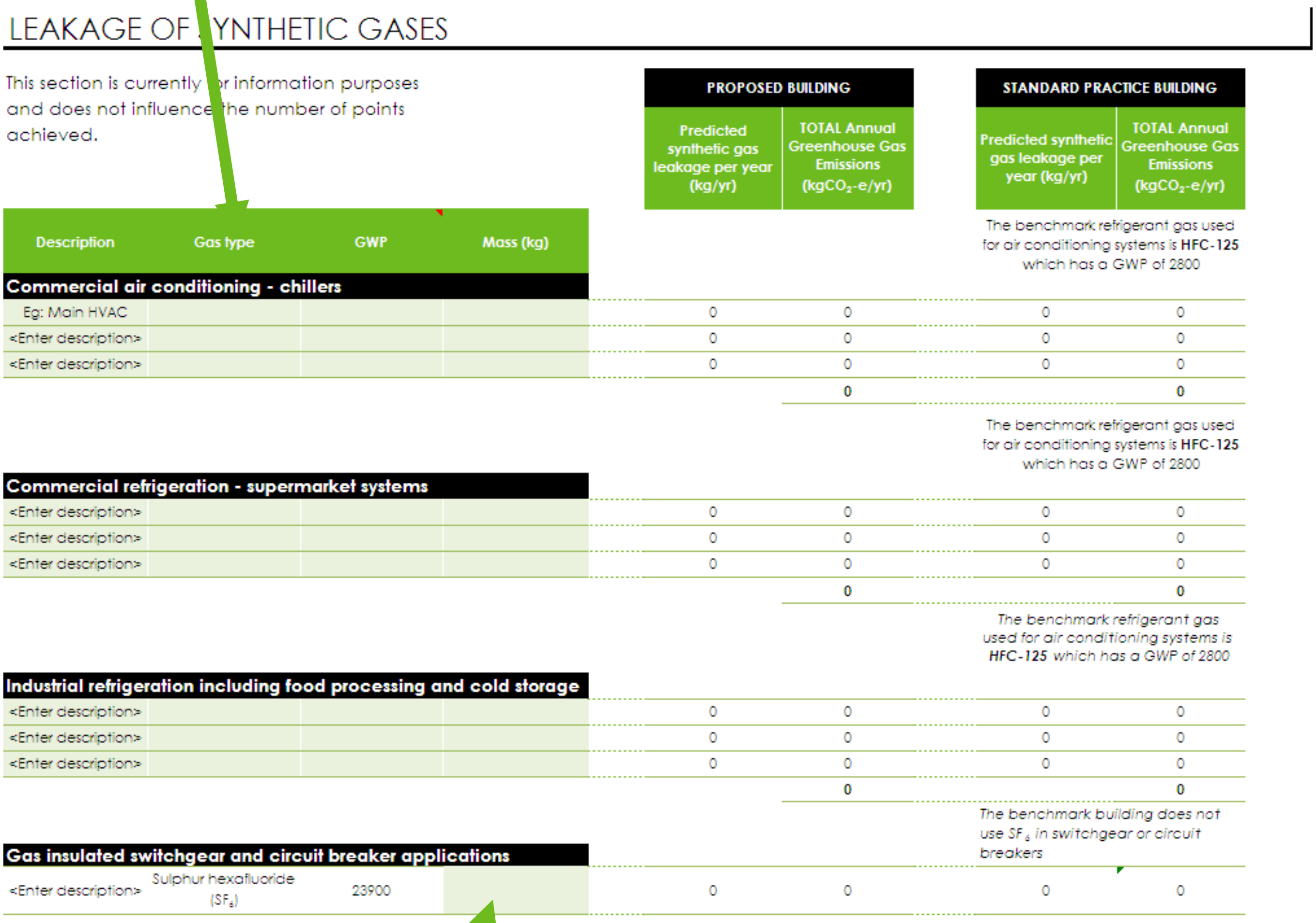
From Renewable Energy	
From Co-generation and Tri-generation (kWh/yr)	

Figure 3: Energy consumption and generation section of the excel tool

The calculator then multiplies the energy consumption by the appropriate greenhouse gas emissions factor to determine the annual greenhouse gas emissions from both the Proposed and Standard Practice Building. The greenhouse gas emissions for each end use are presented in the ‘Energy consumption and generation’ section as shown in Figure 3 above.

The ‘Synthetic gas leakage’ section

Enter the HVAC description, gas type, the GWP and the Mass of the



LEAKAGE OF YNTHETIC GASES

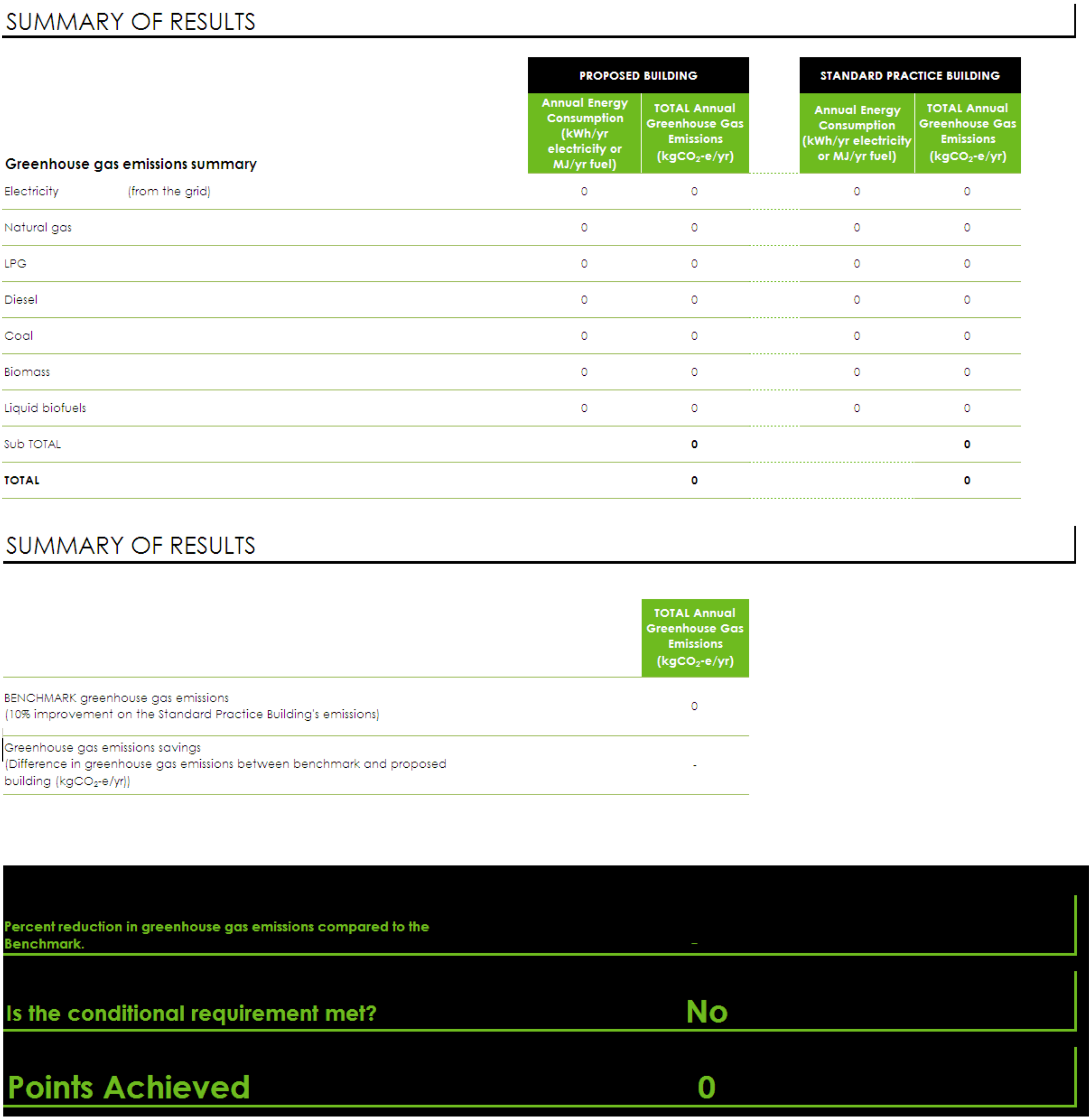
This section is currently r information purposes and does not influence the number of points achieved.

				PROPOSED BUILDING		STANDARD PRACTICE BUILDING	
Description	Gas type	GWP	Mass (kg)	Predicted synthetic gas leakage per year (kg/yr)	TOTAL Annual Greenhouse Gas Emissions (kgCO$_2$-e/yr)	Predicted synthetic gas leakage per year (kg/yr)	TOTAL Annual Greenhouse Gas Emissions (kgCO$_2$-e/yr)
						The benchmark refrigerant gas used for air conditioning systems is **HFC-125** which has a GWP of 2800	
Commercial air conditioning - chillers							
Eg: Main HVAC				0	0	0	0
<Enter description>				0	0	0	0
<Enter description>				0	0	0	0
					0		**0**
						The benchmark refrigerant gas used for air conditioning systems is **HFC-125** which has a GWP of 2800	
Commercial refrigeration - supermarket systems							
<Enter description>				0	0	0	0
<Enter description>				0	0	0	0
<Enter description>				0	0	0	0
					0		**0**
						*The benchmark refrigerant gas used for air conditioning systems is **HFC-125** which has a GWP of 2800*	
Industrial refrigeration including food processing and cold storage							
<Enter description>				0	0	0	0
<Enter description>				0	0	0	0
<Enter description>				0	0	0	0
					0		**0**
						The benchmark building does not use SF$_6$ in switchgear or circuit breakers	
Gas insulated switchgear and circuit breaker applications							
<Enter description>	Sulphur hexafluoride (SF$_6$)	23900		0	0	0	0

Enter the Mass of the refrigerants used

The ‘Results’ section

The Results section provides a summary of the annual energy consumption greenhouse gas emissions, by fuel type, of the Proposed and Standard Practice Buildings. The Energy - Conditional Requirement is calculated (10% below the emissions of the Standard Practice Building). The savings in greenhouse gas emissions and points achieved are then calculated. Whether the conditional requirement is met is also displayed in this section.



SUMMARY OF RESULTS

	PROPOSED BUILDING		STANDARD PRACTICE BUILDING	
Greenhouse gas emissions summary	Annual Energy Consumption (kWh/yr electricity or MJ/yr fuel)	TOTAL Annual Greenhouse Gas Emissions (kgCO$_2$-e/yr)	Annual Energy Consumption (kWh/yr electricity or MJ/yr fuel)	TOTAL Annual Greenhouse Gas Emissions (kgCO$_2$-e/yr)
Electricity (from the grid)	0	0	0	0
Natural gas	0	0	0	0
LPG	0	0	0	0
Diesel	0	0	0	0
Coal	0	0	0	0
Biomass	0	0	0	0
Liquid biofuels	0	0	0	0
Sub TOTAL		**0**		**0**
TOTAL		**0**		**0**

SUMMARY OF RESULTS

	TOTAL Annual Greenhouse Gas Emissions (kgCO$_2$-e/yr)
BENCHMARK greenhouse gas emissions (10% improvement on the Standard Practice Building's emissions)	0
Greenhouse gas emissions savings (Difference in greenhouse gas emissions between benchmark and proposed building (kgCO$_2$-e/yr))	-

Percent reduction in greenhouse gas emissions compared to the Benchmark.	-
Is the conditional requirement met?	**No**
Points Achieved	**0**

Figure 4: Results section of the GHG Calculator tool

4. Greenhouse Gas Emissions Modelling Report

All project teams are required to submit a ‘Greenhouse Gas Emissions Modelling Report’. This report must contain the following:

1. An Executive Summary;
2. The completed *Energy Modelling Summary Form* (See Appendix G);
3. A description of the energy simulation package;
4. A description of the Proposed and Standard Practice Buildings models;
5. Energy consumption results for the Proposed and Standard Practice Buildings;
6. Where applicable, details of synthetic gases included in the building;
7. Greenhouse Gas Emissions of the Proposed and Standard Practice Buildings; and
8. Other energy consumption and energy generation calculations for the Proposed and Standard Practice Buildings;

All inputs must reference the relevant excerpts from specifications, drawings and schedules as provided in the submission. Where these documents are referenced, revision numbers must be included. Any additional materials used in the calculations, such as those used to establish the reference case for refrigeration systems, must be appropriately referenced, with the relevant extracts included.

All other documentation must be provided in accordance with the Technical Manual.

Executive Summary

The executive summary must include at a minimum:

- An overview of the Proposed Building including:
    - A description of all systems installed and their environmental performance;
    - A description of energy saving features; and
    - A description of the overall control systems. The description must include an analysis of the benefits and conflicts of having these control strategies working alongside each other. The following must be considered:
        - Control(s) of any building envelope elements (glazing, shading devices, etc);
        - Lighting/daylighting interaction(s);
        - Air / plant side HVAC control(s); and
        - Where relevant, a summary of the synthetic gas type(s) and mass.
- A brief overview of the main attributes of the Standard Practice Building;
- A description of any compromises made in regards to the modelling of the building and what effect they have on the results;
- A summary of both the Proposed and Standard Practice Building energy consumption by end use and fuel type, and where relevant, contributions from synthetic gas leakage; and
- A summary of the greenhouse gas emissions of the Proposed and Standard Practice Building.

Energy Modelling Summary Form

The Energy Modelling Summary Form must be completed and included as part of the Greenhouse Gas Emissions Modelling Report. This form is included at the end of this chapter and is also available from GBCA website.

A description of the energy simulation package;

The simulation package description must include at a minimum:

- Confirmation and details of which of the following standards, the simulation package complies with:
    - BESTEST (US NREL, 2005); or
    - The European Union draft standard EN13791 July 2000; or
    - Be certified in accordance with ANSI/ASHRAE Standard 140-2001.
- Confirmation that the building performance is analysed on an hourly basis for a full year;
- Details of the weather data file selected (type of data and weather station location);
- A description of the simulation package's limitations at representing:
    - The Proposed and Standard Practice HVAC systems and HVAC plant (If relevant to the buildings' systems; e.g. how the simulation package models multiple chillers and reticulation loops);
    - The HVAC controls strategies which are to be used;
    - Glazing on the building – whether the model represents glazing as only a U-value and shading coefficient;
    - The performance curves and sizes for plant items; and
    - The daylighting effects and the operation of daylight controls.

A description of the Proposed and Standard Practice Buildings models;

This section must clearly identify all default values used (e.g. occupant density) and all design-driven inputs. Each item must clearly reference drawings, schedules and specifications and whenever assumptions are used, any additional materials required to justify the assumption. Where compromises have been made with how the building or building's systems have been modelled, an explanation must be provided and justified.

Note: The following items are the same for both the Proposed and Standard Practice buildings

BUILDING FORM AND ENVELOPE:

Details need to be provided on:

- How the building's physical shape has been represented in the model, including any simplifications and their anticipated effect;
- How the insulating properties of the building have been represented in the model;
- How the glazing has been modelled;
- The window and spandel sizes that have been used in the model;
- How overshadowing from the external environment has been represented in the model;
- How window shading and external building fabric are represented in the model;
- How the orientation has been represented in the model; and
- How infiltration has been modelled.

INTERNAL LOADS AND HVAC DESIGN PARAMETERS

Details of the internal loads and HVAC design parameters assumed for each space need to be provided, including:

- How each relevant space type was chosen for each section of the building;
- The occupancy and operational profiles used;
- The internal loads for lighting, equipment and the occupancy density used; and
- Justification of the metabolic rates used, including the assumed level of activity, the metabolic rate for that activity and the source of the metabolic rates used.
- The temperature bands, outside air and infiltration rates modelled.

Where spaces have been modeled with broader temperature bands than those required by the BCA (see Appendix A for further information), the following must also be provided:

- Extract(s) from the mechanical specifications listing the space temperature bands and confirming that these design criteria have been used for system sizing and selection, and
- A letter from the owner confirming 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

Note: The following sections must be provided separately for the Proposed and Standard Practice buildings

HVAC SYSTEM SIMULATION

Details need to be provided, with supporting documentation, showing how the following aspects of the HVAC system have been modelled/represented in the model:

- HVAC system design;
- Air-conditioning zones (showing how they accurately reflect system performance and zonal solar diversity);
- Chiller plant, including:
    - chiller plant size;

  - efficiency curves (including details of how the chiller COP profiles have been modelled with regard to heat loads and ambient conditions).

- Boiler plant, including:
  - boiler plant size;
  - thermal efficiency;
  - fuel type; and
  - distribution efficiency.
- Ventilation fans, including details on how the index run pressure drops have been calculated and modelled and including:
  - Fan Maximum Total Motor Shaft Power;
  - Maximum Fan Motor Power to Air Flow Rate Ratio; and
  - Total system static pressure (including filters, coils and diffusers).
- Cooling tower fans (where relevant, including any supplementary cooling load for tenancy air conditioning); and
- Cooling tower and condenser water pumping (where relevant, including any supplementary cooling load for tenancy air conditioning).

HVAC PUMPING

Details need to be provided, with supporting documentation, showing how the following aspects of the HVAC pumping have been calculated:

- Chilled water pumping, (showing how it has been calculated using the building cooling load, the static pressure of the chilled water pumps and the flow rate in L/s.)
- Heating hot water pumping (showing how it has been calculated using the building heating load, the static pressure of the hot water pumps and the flow rate in L/s.)
- If relevant, tenant condenser water loop (showing what allowance has been made for the additional energy used for tenant supplementary condenser water pumping).
- If relevant, the tenant condenser water loop pumping (showing how it has been calculated based on a tenant supplementary cooling load, the static pressure of the tenant condenser water pumps and the flow rate in L/s); and
- Pump maximum motor shaft power.

HVAC CONTROLS

Details need to be provided, with supporting documentation, showing how the following HVAC Controls have been modelled/represented in the model:

- Outdoor air flows;
- Economy cycles (including details of how they have been modelled to reflect system specification noting any enthalpy/temperature cut-off and control point);
- Primary duct temperature control (including details on how design temperatures and setpoints have been modelled);
- Airflow control (showing the control logic);
- Minimum turndown for each air supply (where relevant),
- Chiller staging strategy (where relevant, including showing how the correct controls are modelled to reflect the actual relationship between the chillers).
- Air side system configuration and space temperature controls strategy.

INTERNAL LIGHTING

Details need to be provided, with supporting documentation, for each separately switched/dimmed zone, showing:

- How the lighting power densities (or adjusted lighting power densities) are calculated, including:
    - Luminaire type and power rating (including lamp and control gear);
    - Where automatic controls are installed, details need to be provided on the type of control; the adjustment factor being used; area/number of luminaires controlled (as appropriate for the Green Star Adjustment Factor); and any parasitic power consumption of the control system itself.
    - Where an individually addressable lighting system is being installed, confirmation is required that no zone exceeds the area requirements or number of luminaires requirements for the adjustment factor being used.
- The operational profile for lighting from Appendix A that is used.

Note on supporting documentation for internal lighting:

The lighting plans must identify the control zone, the locations of the luminaires, switches and the automated control components (which could include motion detectors, light level sensors, user interfaces, BMS interfacing and time switches).

Where an individually addressable lighting system is provided, the plans must contain all soft switches highlighted and identified including an electrical services legend that identifies the various symbols on the drawings (a soft switch is defined as an addressable switching mechanism such as light level detectors, motion detectors and light switches which are connected to an addressable lighting control system). The drawings provided must represent each typical floor/lighting layout (i.e. a typical lighting layout); where lighting layouts are different on each floor, drawings for each floor must be provided.

EXTERNAL LIGHTING

Details of the external lighting energy consumption calculations need to be provided, with supporting documentation, including:

- The extent of external lighting on the site;
- For the Proposed Building: the horizontal lux provisions, and whether these meet the requirements of AS 1158.3.1;
- The lighting power density calculations;
- The operational profiles for external lighting used; and
- Calculation of the energy consumption.

DOMESTIC HOT WATER

Details of the domestic hot water (DHW) energy consumption calculations need to be provided, with supporting documentation, including:

- The outputs from the completed Green Star –Potable Water Calculator, showing the DHW demand for the Proposed and Standard Practice Buildings;
- Details of the DHW generator (including system type, capacity, fuel type and efficiency);
- Details of the DHW storage tanks (where relevant), including standing losses; and
- Calculation of the energy consumption.

LIFTS, ESCALATORS AND TRAVELATORS

Lift, escalator and travelator energy consumption calculations need to be provided, with supporting documentation, in accordance with the methodology given in Appendix C Energy Consumption Adjustment Factors.

MECHANICAL EXHAUST

Details of the energy requirement of mechanical ventilation (such as those installed for toilets, kitchens, purpose specific systems such as photocopy or computer server room exhausts etc...) need to be provided, with supporting documentation, including:

- Details of the mechanical exhaust system (description of fan and all parameters used to calculated the energy consumption);
- The operational profile used (note - the fan should be on anytime that the HVAC system is on);
- For car park and loading dock ventilation systems, where the Green Star Adjustment Factor for atmospheric contaminant monitoring systems and variable speed drive fans has been used, a description of how the atmospheric contaminant monitoring sensors have been located to adequately detect the atmospheric contaminant and how the system responds to changes in the atmospheric contaminant level must be provided.

OTHER ENERGY CONSUMPTION

Details of all other energy consumption calculations (eg: Black Water plant) need to be provided including justification of the appropriateness of energy consumption methodology used and operational assumptions, with supporting documentation all inputs.

ELECTRICITY GENERATION

A description of how the electricity generation has been calculated/modelled, including all operational assumptions and supporting documentation, including:

- A description of the energy generation system (including system type, capacity, fuel type, and efficiency);
- For renewable energy systems: the calculation of the renewable resource (eg: solar or wind resource), including all assumption used;
- For co-generation/tri-generation systems: all assumptions with regards to
  - Heat and power demand
  - Equipment efficiencies
  - Thermal/power storage

Total energy consumption for the Proposed and Standard Practice Buildings

The energy consumption of the Proposed and Standard Practice Building, broken down by end use and by fuel type needs to be provided. The relevant simulation outputs and calculation results should be included for both the Proposed and Standard Practice Building.

Greenhouse Gas Emissions of the Proposed and Standard Practice Buildings

The greenhouse gas emissions, as calculated by the Green Star – Greenhouse Gas Emissions Calculator need to be provided.

Other energy consumption and energy generation calculations

Any relevant calculations, justifications, addendums and the like must be included in this section of the energy report.

References & Appendices

5. References

- Air-Conditioning, Heating, and Refrigeration Institute (formerly ARI) (2003), Performance Rating of Water Chilling Packages Using the Vapor Compression Cycle, ARI 550/590-2003: http://www.ahrinet.org/ accessed December 2009.
- Australian Building Codes Board (ABCB) (2008), Volume One Class 2-9 Buildings, BCA 2008, Australian Building Codes Board, Australia.
- Australian Building Codes Board (ABCB) (2006), *Protocol for Energy Analysis Software 2006.1*, http://www.abcb.gov.au/index.cfm?objectid=6928102C-F27E-4834-0B94E42A0568F11B, accessed June, 2009.
- American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) (2007), *Energy Standard for Buildings Except Low-Rise Residential Buildings (SI Edition)*, ASHRAE Standard 90.1-2007 SI Edition, http://www.ashrae.org/technology/page/548, accessed June, 2009.
- Barney, G. (2007), *'Energy efficiency of lifts – measurement, conformance, modelling, prediction and simulation' (presentation)*, www.cibseliftsgroup.org/CIBSE/papers/Barney-on-energy%20efficiency%20of%20lifts.pdf, accessed June, 2009.
- Department of Climate Change (DCC) (2009), *The National Greenhouse Accounts (NGA) Factors*, http://www.climatechange.gov.au/en/climate-change/emissions.aspx, June, 2009.
- International Organization for Standardization (ISO) (2008), *Energy performance of lifts and escalators - Part 1: Energy measurement and conformance,* ISO/DIS 25745-1: 2008 (Draft standard - currently under development), International Organization for Standardization, Geneva.
- Intergovernmental Panel on Climate Change (IPCC) (1996), *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories,* http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.html, accessed December, 2009.
- New South Wales Health (NSW Health) (2007), *Technical Series 11: Engineering Services and Sustainable Development Guidelines*, www.healthfacilityguidelines.com.au, accessed June 2008

- Standards Australia (SA) (1991), The use of ventilation and airconditioning in buildings, Part 2: Ventilation design for indoor air contaminant control (excluding requirements for the health aspects of tobacco smoke exposure), AS 1668.2:1991, SAI Global, Australia
- Standards Australia/Standards New Zealand (SA/SNZ) (2008), Liquid-chilling packages using the vapour compression cycle, Part 2: Minimum energy performance standard (MEPS) and compliance requirements, AS/NZS 4776.2:2008, SAI Global, Australia
- The United States Environmental Protection Agency Glossary of Climate Change Terms webpage ((US EPA) (2009) http://www.epa.gov/climatechange/glossary.html), accessed December 2009.

Appendix A. HVAC design parameters and occupancy and operational profiles

This appendix contains design parameters which must be used to model the proposed and standard Practice building's HVAC systems. It also contains the occupancy and operational profiles which need to be applied to each zone within the facility under assessment.

When calculating the energy consumption of the lighting of the proposed building, the lighting profile in this Appendix should be used in conjunction with the lighting densities as per the lighting specification.

HVAC DESIGN PARAMETERS

As specified in Item 10 (Heating Ventilation and Air Conditioning) of Table 1 of this guide, the heat loads and design parameters in this Appendix should be used in place of those given in BCA Specification JV, clause 2. (a). These parameters are given in Table 3 for the proposed and Standard Practice buildings.

	Proposed building	Standard Practice building
Temperature band	For all air conditioned spaces, except for process/manufacturing spaces and specialist labs such as clean rooms, the air conditioning must be modeled on the basis of the space temperature being within the range stipulated in BCA Section J, Specification JV clause 2. (a) (i); between 20°CBD – 24°CBD for 98% of the plant operation time. Process/manufacturing and specialist labs such as clean rooms, must be modeled on the basis of the design temperature and humidity controls. Where spaces in the building have been designed to operate comfortably within a broader temperature band, this temperature band may be used in the modeling provided: • 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 PMV calculations are being undertaken,	As proposed building, except for when the proposed building has been designed to operate under broader temperature bands.

	Proposed building	Standard Practice building
	the same internal conditions must be used.	
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 Table D1.13 of the BCA should be used, or as delineated in the relevant profile in this guide.	As proposed building
Sensible and Latent heat gains per person	The degree of activity within each space must be assessed by the design team and the appropriate sensible and latent gains used. Acceptable sources of metabolic rates include AIRAH, ASHRAE and CIBSE guidance.	As proposed building
Maximum lighting	The maximum lighting power density that should be used in conjunction with the lighting profile should be the 'Adjusted Lighting Power Density' used to calculate the energy consumption from lighting in the proposed building design (i.e. after the adjustment factors given in Appendix C have been applied).	The maximum lighting power density that should be used in conjunction with the lighting profiles should be as required by BCA Section J, Part J6: Artificial lighting and power.
Maximum equipment	The equipment loads that must used in conjunction with the equipment profiles are given in Table 3: **HVAC Design parameters**	As proposed building
Outside air rate	Outside air rates must be in accordance with the engineered design. Outside air rates must not be modulated depending on the occupancy schedules unless demand-controlled ventilation systems are being installed.	Standard Practice building outside air rate must be as BCA Section J, Specification JV clause 2. (a) (iv) 'The amount of ventilation required by Part F4'.
Infiltration rate	The infiltration rate assumed for all spaces, except for cold rooms, should be as specified in the BCA Section J, Specification JV clause 2. (a) (vi). The infiltration for cold rooms must be calculated by the design team and take into consideration the operating hours and building fabric specification.	As proposed building.

Table 3: HVAC Design parameters

Space type		**Equipment load (W/m^2)**
Office		11W/m^2
Industrial spaces	Where temperature control is localised and is not designed to handle equipment loads (eg a manufacturing space etc...)	0W/m^2
	General industrial spaces (laboratory, workshop, warehouse etc..)	15W/m^2
	Where the HVAC system has been specifically designed to handle the equipment loads from a defined industrial process (eg: a clean room, server room, cold room etc...).	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.
Showroom		5W/m^2
Fire Station		8 W/m^2 in office area 1 W/m^2 elsewhere
Kitchen		200W/m^2
Gym		15W/m^2
Secondary spaces (eg: circulation, corridors, stairways, store rooms, car parks)		0W/m^2

Table 4: Equipment gains

OCCUPANCY AND OPERATIONAL PROFILES

The profiles must be used in combination with the occupancy, lighting and equipment load figures given in Table 3 and Table 4. These profiles provide typical hours of operation for the majority of space types.

The simulator should choose the profile most appropriate for each space within the facility. If none of the profiles provided give a reasonable estimation of the expected hours of operation of a particular space, the design team should submit a Credit Interpretation Request (CIR) to the GBCA.

The profiles provided include:

- **Normal working day:** spaces that are typically operated for one shift). Examples of spaces that would use these profiles are office spaces, workshops, laboratories, clean rooms and any other space that will be occupied for normal working hours.
- **Long working day:** spaces that will be typically operated for more than one shift). Examples of spaces that would use these profiles are warehouse spaces and production/manufacturing spaces.

- **24 hour work space:** spaces that will be typically operated for 24 hours). Examples of spaces that would use these profiles are 24 hour warehouse spaces and production/manufacturing spaces.
- **Retail/Factory Shop/Showroom:** These profiles should be used for areas involved in the sale of goods. Areas such as direct factory outlets are included within this space type.
- **Cool Room / Freezer:**
  - Short and long term storage; and
  - Distribution centres

These profiles should be used for cool rooms/ cold rooms and walk in freezers only; display cabinets, small scale freezers are classified as equipment and excluded from the energy consumption calculations.

- **Kitchen**: These profiles should be used for on-site (non-industrial) kitchens.
- **Common Area**: Examples of spaces that would use these profiles are break-out spaces, lunch rooms, gyms and reception areas. First aid rooms may also be included within this category.
- **Transient spaces**: These profiles should be used for all spaces that are lit and have low transient occupancy. Examples of spaces that would use these profiles are corridors and stairways.
- **Back of house**: These profiles 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 these profiles are engineering or maintenance services, server rooms, mechanical services and materials management areas.
- **Internal car parks**
- **External lighting** – External lighting applications that would use these profiles include pathway lighting, decorative lighting, landscape lighting and external car park lighting, but excluding emergency lighting

Normal working day

Examples of spaces that would use these profiles are office spaces, workshops, laboratories, clean rooms and any other space that will be occupied for normal working hours.

These profiles should be used for five, six or seven days per week, in line with the operation of the proposed building. On un-occupied/off-peak days, 0% occupancy, 15% lighting and 15% equipment loads must be assumed. The plant is assumed to be 'off'.

	Occupancy (%)	Lighting (%)	Equipment (%)	Plant Operation
12am – 1am	0%	15%	15%*	Off
1am – 2am	0%	15%	15%*	Off
2am – 3am	0%	15%	15%*	Off
3am – 4am	0%	15%	15%*	Off
4am – 5am	0%	15%	15%*	Off
5am – 6am	0%	15%	15%*	Off
6am – 7am	0%	15%	15%*	Off
7am – 8am	15%	40%	65%	On
8am – 9am	50%	90%	80%	On
9am – 10am	70%	100%	100%	On
10am – 11am	70%	100%	100%	On
11am – 12pm	70%	100%	100%	On
12pm – 1pm	70%	100%	100%	On
1pm – 2pm	70%	100%	100%	On
2pm – 3pm	70%	100%	100%	On
3pm – 4pm	70%	100%	100%	On
4pm – 5pm	70%	100%	100%	On
5pm – 6pm	40%	80%	80%	On
6pm – 7pm	15%	60%	65%	Off
7pm – 8pm	5%	60%	55%	Off
8pm – 9pm	5%	50%	55%	Off
9pm – 10pm	0%	15%	15%*	Off
10pm – 11pm	0%	15%	15%*	Off
11pm – 12am	0%	15%	15%*	Off

* For office spaces with IT equipment, the standby equipment use figure should be 50% rather than 15%.

LONG WORKING DAY

Examples of spaces that would use these profiles are warehouse spaces and production/manufacturing spaces.

These profiles should be used for five, six or seven days per week, in line with the operation of the proposed building. On un-occupied/off-peak days, 0% occupancy, 15% lighting and 15% equipment loads must be assumed. The plant is assumed to be 'off'.

	Occupancy (%)	Lighting (%)	Equipment (%)	Plant Operation
12am – 1am	0%	15%	15%*	Off
1am – 2am	0%	15%	15%*	Off
2am – 3am	0%	15%	15%*	Off
3am – 4am	0%	15%	15%*	Off
4am – 5am	15%	40%	65%	On
5am – 6am	50%	90%	80%	On
6am – 7am	70%	100%	100%	On
7am – 8am	70%	100%	100%	On
8am – 9am	70%	100%	100%	On
9am – 10am	70%	100%	100%	On
10am – 11am	70%	100%	100%	On
11am – 12pm	70%	100%	100%	On
12pm – 1pm	70%	100%	100%	On
1pm – 2pm	70%	100%	100%	On
2pm – 3pm	70%	100%	100%	On
3pm – 4pm	70%	100%	100%	On
4pm – 5pm	70%	100%	100%	On
5pm – 6pm	70%	100%	100%	On
6pm – 7pm	70%	100%	100%	On
7pm – 8pm	70%	100%	100%	On
8pm – 9pm	70%	100%	100%	On
9pm – 10pm	40%	80%	80%	On
10pm – 11pm	15%	60%	65%	Off
11pm – 12am	0%	15%	15%*	Off

* For office spaces with IT equipment, the standby equipment use figure should be 50% rather than 15%.

24 hour work space

Examples of spaces that would use these profiles are 24 hour warehouse spaces and production/manufacturing spaces. These profiles should be used for five, six or seven days per week, in line with the operation of the proposed building. On un-occupied/off-peak days, 0% occupancy, 15% lighting and 15% equipment loads must be assumed. The plant is assumed to be 'off'.

	Occupancy (%)	Lighting (%)	Equipment (%)	Plant Operation
12am – 1am	70%	100%	100%	On
1am – 2am	70%	100%	100%	On
2am – 3am	70%	100%	100%	On
3am – 4am	70%	100%	100%	On
4am – 5am	70%	100%	100%	On
5am – 6am	70%	100%	100%	On
6am – 7am	70%	100%	100%	On
7am – 8am	70%	100%	100%	On
8am – 9am	70%	100%	100%	On
9am – 10am	70%	100%	100%	On
10am – 11am	70%	100%	100%	On
11am – 12pm	70%	100%	100%	On
12pm – 1pm	70%	100%	100%	On
1pm – 2pm	70%	100%	100%	On
2pm – 3pm	70%	100%	100%	On
3pm – 4pm	70%	100%	100%	On
4pm – 5pm	70%	100%	100%	On
5pm – 6pm	70%	100%	100%	On
6pm – 7pm	70%	100%	100%	On
7pm – 8pm	70%	100%	100%	On
8pm – 9pm	70%	100%	100%	On
9pm – 10pm	70%	100%	100%	On
10pm – 11pm	70%	100%	100%	On
11pm – 12am	70%	100%	100%	On

Retail/Factory Shop/Showroom.

These profiles should be used for areas involved in the sale of goods. Areas such as direct factory outlets are included within this space type.

These profiles should be used for five, six or seven days per week, in line with the operation of the proposed building. On un-occupied/off-peak days, 0% occupancy, 15% lighting and 15% equipment loads must be assumed. The plant is assumed to be 'off'.

	Occupancy (%)	Lighting (%)	Equipment (%)	Plant Operation
12am – 1am	0%	15%	15%	Off
1am – 2am	0%	15%	15%	Off
2am – 3am	0%	15%	15%	Off
3am – 4am	0%	15%	15%	Off
4am – 5am	0%	15%	15%	Off
5am – 6am	0%	15%	15%	Off
6am – 7am	0%	15%	15%	Off
7am – 8am	10%	100%	70%	On
8am – 9am	20%	100%	70%	On
9am – 10am	20%	100%	70%	On
10am – 11am	15%	100%	70%	On
11am – 12pm	25%	100%	70%	On
12pm – 1pm	25%	100%	70%	On
1pm – 2pm	15%	100%	70%	On
2pm – 3pm	15%	100%	70%	On
3pm – 4pm	15%	100%	70%	On
4pm – 5pm	15%	100%	70%	On
5pm – 6pm	5%	100%	70%	On
6pm – 7pm	5%	100%	70%	Off
7pm – 8pm	0%	15%	15%	Off
8pm – 9pm	0%	15%	15%	Off
9pm – 10pm	0%	15%	15%	Off
10pm – 11pm	0%	15%	15%	Off
11pm – 12am	0%	15%	15%	Off

Fire Station Bedrooms

For use in ‘bedroom areas’ within fire stations.

	Occupancy (%)	Lighting (%)	Equipment (%)	Plant Operation
12am – 1am	100%	0%	100%	On
1am – 2am	100%	0%	100%	On
2am – 3am	100%	0%	100%	On
3am – 4am	100%	0%	100%	On
4am – 5am	100%	0%	100%	On
5am – 6am	100%	0%	100%	On
6am – 7am	0%	100%	100%	On
7am – 8am	0%	100%	100%	On
8am – 9am	0%	0%	100%	On
9am – 10am	0%	0%	100%	On
10am – 11am	0%	0%	100%	On
11am – 12pm	0%	0%	100%	On
12pm – 1pm	0%	0%	100%	On
1pm – 2pm	0%	0%	100%	On
2pm – 3pm	0%	0%	100%	On
3pm – 4pm	0%	0%	100%	On
4pm – 5pm	0%	0%	100%	On
5pm – 6pm	0%	0%	100%	On
6pm – 7pm	0%	100%	100%	On
7pm – 8pm	0%	100%	100%	On
8pm – 9pm	0%	100%	100%	On
9pm – 10pm	0%	100%	100%	On
10pm – 11pm	100%	100%	100%	On
11pm – 12am	100%	0%	100%	On

Fire Station General

For use in all non-bedroom areas within fire stations.

	Occupancy (%)	Lighting (%)	Equipment (%)	Plant Operation
12am – 1am	100%	100%	100%	On
1am – 2am	100%	100%	100%	On
2am – 3am	100%	100%	100%	On
3am – 4am	100%	100%	100%	On
4am – 5am	100%	100%	100%	On
5am – 6am	100%	100%	100%	On
6am – 7am	100%	50%	100%	On
7am – 8am	100%	50%	100%	On
8am – 9am	100%	50%	100%	On
9am – 10am	100%	50%	100%	On
10am – 11am	100%	50%	100%	On
11am – 12pm	100%	50%	100%	On
12pm – 1pm	100%	50%	100%	On
1pm – 2pm	100%	50%	100%	On
2pm – 3pm	100%	50%	100%	On
3pm – 4pm	100%	50%	100%	On
4pm – 5pm	100%	50%	100%	On
5pm – 6pm	100%	50%	100%	On
6pm – 7pm	100%	100%	100%	On
7pm – 8pm	100%	100%	100%	On
8pm – 9pm	100%	100%	100%	On
9pm – 10pm	100%	100%	100%	On
10pm – 11pm	100%	100%	100%	On
11pm – 12am	100%	100%	100%	On

Cool Room / Freezer - Short and long term storage

These profiles should be used for cool rooms/ cold rooms and walk in freezers which are used for short or long term storage; display cabinets, small scale freezers are classified as equipment and excluded from the energy consumption calculations.These profiles should be used for three days per week for short term storage and one day per week for long term storage. On un-occupied/off-peak days, no infiltration load, 0% occupancy, 15% lighting and 0% loads must be assumed. The plant operation is assumed to be ‘on’.

	Occupancy (%)	Lighting (%)	Equipment (%)	Plant Operation
12am – 1am	0%	15%	0%	On
1am – 2am	0%	15%	0%	On
2am – 3am	0%	15%	0%	On
3am – 4am	0%	15%	0%	On
4am – 5am	15%	60%	40%	On
5am – 6am	70%	100%	100%	On
6am – 7am	70%	100%	100%	On
7am – 8am	70%	100%	100%	On
8am – 9am	30%	100%	60%	On
9am – 10am	0%	10%	0%	On
10am – 11am	0%	10%	0%	On
11am – 12pm	0%	10%	0%	On
12pm – 1pm	0%	10%	0%	On
1pm – 2pm	0%	10%	0%	On
2pm – 3pm	0%	10%	0%	On
3pm – 4pm	0%	10%	0%	On
4pm – 5pm	0%	10%	100%	On
5pm – 6pm	70%	100%	100%	On
6pm – 7pm	70%	100%	100%	On
7pm – 8pm	70%	100%	100%	On
8pm – 9pm	15%	60%	39%	On
9pm – 10pm	0%	15%	0%	On
10pm – 11pm	0%	15%	0%	On
11pm – 12am	0%	15%	0%	On

Cool Room / Freezer – Distribution centres

These profiles should be used for cool rooms/ cold rooms and walk in freezer which are part of a distribution centre only; display cabinets, small scale freezers are classified as equipment and excluded from the energy consumption calculations.

These profiles should be used seven days per week.

	Occupancy (%)	Lighting (%)	Equipment (%)	Plant Operation
12am – 1am	0%	15%	0%	On
1am – 2am	0%	15%	0%	On
2am – 3am	0%	15%	0%	On
3am – 4am	0%	15%	0%	On
4am – 5am	15%	60%	40%	On
5am – 6am	70%	100%	100%	On
6am – 7am	70%	100%	100%	On
7am – 8am	70%	100%	100%	On
8am – 9am	5%	100%	10%	On
9am – 10am	5%	100%	10%	On
10am – 11am	5%	100%	10%	On
11am – 12pm	50%	100%	100%	On
12pm – 1pm	50%	100%	100%	On
1pm – 2pm	50%	100%	100%	On
2pm – 3pm	5%	100%	10%	On
3pm – 4pm	5%	100%	10%	On
4pm – 5pm	5%	100%	10%	On
5pm – 6pm	5%	100%	10%	On
6pm – 7pm	70%	100%	100%	On
7pm – 8pm	70%	100%	100%	On
8pm – 9pm	70%	100%	100%	On
9pm – 10pm	70%	100%	100%	On
10pm – 11pm	10%	40%	10%	On
11pm – 12am	10%	40%	10%	On

Kitchen

These profiles should be used for on-site (non-industrial) kitchens.

These profiles should be used for five, six or seven days per week, in line with the operation of the proposed building. On un-occupied/off-peak days, 0% occupancy, 15% lighting and 15% equipment loads must be assumed. The plant is assumed to be ‘off’.

	Occupancy (%)	Lighting (%)	Equipment (%)	Plant Operation
12am – 1am	0%	15%	15%	Off
1am – 2am	0%	15%	15%	Off
2am – 3am	0%	15%	15%	Off
3am – 4am	0%	15%	15%	Off
4am – 5am	0%	15%	15%	Off
5am – 6am	0%	15%	15%	Off
6am – 7am	20%	100%	20%	On
7am – 8am	50%	100%	40%	On
8am – 9am	100%	100%	20%	On
9am – 10am	100%	100%	30%	On
10am – 11am	100%	100%	100%	On
11am – 12pm	100%	100%	100%	On
12pm – 1pm	100%	100%	20%	On
1pm – 2pm	100%	100%	30%	On
2pm – 3pm	100%	100%	30%	On
3pm – 4pm	100%	100%	20%	On
4pm – 5pm	80%	100%	20%	On
5pm – 6pm	20%	100%	20%	On
6pm – 7pm	20%	100%	15%	On
7pm – 8pm	0%	15%	15%	Off
8pm – 9pm	0%	15%	15%	Off
9pm – 10pm	0%	15%	15%	Off
10pm – 11pm	0%	15%	15%	Off
11pm – 12am	0%	15%	15%	Off

Common Area

Examples of spaces that would use these profiles are break-out spaces, lunch rooms, gyms and reception areas. First aid rooms may also be included within this category.

These profiles should be used for five, six or seven days per week, in line with the operation of the proposed building. On un-occupied/off-peak days, 0% occupancy, 15% lighting and 15% equipment loads must be assumed. The plant is assumed to be ‘off’.

	Occupancy (%)	Lighting (%)	Equipment (%)	Plant Operation
12am – 1am	0%	15%	15%	Off
1am – 2am	0%	15%	15%	Off
2am – 3am	0%	15%	15%	Off
3am – 4am	0%	15%	15%	Off
4am – 5am	0%	15%	15%	Off
5am – 6am	0%	15%	15%	Off
6am – 7am	20%	100%	100%	On
7am – 8am	50%	100%	100%	On
8am – 9am	5%	100%	100%	On
9am – 10am	0%	100%	100%	On
10am – 11am	5%	100%	100%	On
11am – 12pm	83%	100%	100%	On
12pm – 1pm	100%	100%	100%	On
1pm – 2pm	5%	100%	100%	On
2pm – 3pm	0%	100%	100%	On
3pm – 4pm	50%	100%	100%	On
4pm – 5pm	0%	100%	100%	On
5pm – 6pm	20%	100%	100%	On
6pm – 7pm	20%	100%	100%	On
7pm – 8pm	0%	15%	15%	Off
8pm – 9pm	0%	15%	15%	Off
9pm – 10pm	0%	15%	15%	Off
10pm – 11pm	0%	15%	15%	Off
11pm – 12am	0%	15%	15%	Off

Secondary spaces

These profiles should be used for all spaces that are lit and have low transient occupancy. Examples of spaces that would use these profiles are corridors and stairways.

These profiles should be used for five, six or seven days per week, in line with the operation of the proposed building. On un-occupied/off-peak days, 0% occupancy, 15% lighting and 15% equipment loads must be assumed. The plant is assumed to be ‘off’.

	Occupancy (%)	Lighting ‘Normal’ (%)	Lighting ‘Long’ (%)	Lighting ’24 hr’ (%)	Equipment (%)	Plant Operation ‘Normal’	Plant Operation ‘Long’	Plant Operation ’24 hr’
12am – 1am	0%	15%	15%	100%	0%	Off	Off	On
1am – 2am	0%	15%	15%	100%	0%	Off	Off	On
2am – 3am	0%	15%	15%	100%	0%	Off	Off	On
3am – 4am	0%	15%	40%	100%	0%	Off	Off	On
4am – 5am	0%	15%	80%	100%	0%	Off	On	On
5am – 6am	0%	15%	100%	100%	0%	Off	On	On
6am – 7am	0%	40%	100%	100%	0%	On	On	On
7am – 8am	0%	80%	100%	100%	0%	On	On	On
8am – 9am	0%	100%	100%	100%	0%	On	On	On
9am – 10am	0%	100%	100%	100%	0%	On	On	On
10am – 11am	0%	100%	100%	100%	0%	On	On	On
11am – 12pm	0%	100%	100%	100%	0%	On	On	On
12pm – 1pm	0%	100%	100%	100%	0%	On	On	On
1pm – 2pm	0%	100%	100%	100%	0%	On	On	On
2pm – 3pm	0%	100%	100%	100%	0%	On	On	On
3pm – 4pm	0%	100%	100%	100%	0%	On	On	On
4pm – 5pm	0%	100%	100%	100%	0%	On	On	On
5pm – 6pm	0%	80%	100%	100%	0%	On	On	On
6pm – 7pm	0%	40%	100%	100%	0%	On	On	On
7pm – 8pm	0%	15%	100%	100%	0%	Off	On	On
8pm – 9pm	0%	15%	100%	100%	0%	Off	On	On
9pm – 10pm	0%	15%	80%	100%	0%	Off	On	On
10pm – 11pm	0%	15%	40%	100%	0%	Off	On	On

11pm – 12am	0%	15%	15%	100%	0%	Off	Off	On

Profile	When to use the different profiles
Normal	When all adjacent areas use the ‘Normal working day’ profile.
Long	When all adjacent areas use either the ‘Normal working day’ or ‘Long working day’ profile.
24 hour	When one or more adjacent areas use the ‘24 hour work space’ profile.

Back of house

These profiles 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 these profiles are engineering or maintenance services, server rooms, mechanical services and waste management areas. The ‘Plant Operation’ section of this profile needs only to be used for conditioned back of house spaces. Otherwise, it is assumed that the space is unconditioned and plant operation is 'Off'. Regardless of the condition of the space, lighting is to be modelled as per this profile.

These profiles should be used for five, six or seven days per week, in line with the operation of the proposed building. On un-occupied/off-peak days, 0% occupancy, 0% lighting and 15% equipment standby power consumption must be assumed. The plant is assumed to be ‘on’.

	Occupancy (%)	Artificial lighting (%)	Equipment 'Normal' (%)	Equipment 'Long' (%)	Equipment '24 hour' (%)	Plant Operation
12am – 1am	0%	0%	15%	15%	100%	On
1am – 2am	0%	0%	15%	15%	100%	On
2am – 3am	0%	0%	15%	15%	100%	On
3am – 4am	0%	0%	15%	15%	100%	On
4am – 5am	0%	0%	15%	65%	100%	On
5am – 6am	0%	0%	15%	80%	100%	On
6am – 7am	0%	0%	15%	100%	100%	On
7am – 8am	0%	10%	65%	100%	100%	On
8am – 9am	0%	10%	80%	100%	100%	On
9am – 10am	0%	10%	100%	100%	100%	On
10am – 11am	0%	10%	100%	100%	100%	On
11am – 12pm	0%	10%	100%	100%	100%	On
12pm – 1pm	0%	10%	100%	100%	100%	On
1pm – 2pm	0%	10%	100%	100%	100%	On
2pm – 3pm	0%	10%	100%	100%	100%	On
3pm – 4pm	0%	10%	100%	100%	100%	On
4pm – 5pm	0%	10%	100%	100%	100%	On
5pm – 6pm	0%	10%	80%	100%	100%	On
6pm – 7pm	0%	10%	65%	100%	100%	On
7pm – 8pm	0%	0%	55%	100%	100%	On
8pm – 9pm	0%	0%	55%	100%	100%	On
9pm – 10pm	0%	0%	15%	80%	100%	On
10pm – 11pm	0%	0%	15%	65%	100%	On
11pm – 12am	0%	0%	15%	15%	100%	On

Profile	When to use the different profiles
Normal	When all work spaces in the building use the ‘Normal working day’ profile.
Long	When all workspaces in the building use either the ‘Normal working day’ or ‘Long working day’ profile.
24 hour	When one or more work spaces use the ‘24 hour work space’ profile.

Internal car parks/loading docks

These profiles should be used for five, six or seven days per week, in line with the operation of the proposed building. On un-occupied/off-peak days, 0% occupancy, 15% lighting and 0% equipment loads must be assumed. The plant is assumed to be 'off'.

Note: Credit may be taken for installing atmospheric contaminant monitoring and VSD fans in by using the Adjustment Factor given in

	Occupancy (%)	Lighting 'Normal'(%)	Lighting 'Long' (%)	Lighting '24 hr' (%)	Equipment (%)	Plant Operation 'Normal'	Plant Operation 'Long'	Plant Operation '24 hr'
12am – 1am	0%	15%	15%	100%	0%	Off	Off	On
1am – 2am	0%	15%	15%	100%	0%	Off	Off	On
2am – 3am	0%	15%	15%	100%	0%	Off	Off	On
3am – 4am	0%	15%	100%	100%	0%	Off	Off	On
4am – 5am	0%	15%	100%	100%	0%	Off	On	On
5am – 6am	0%	15%	100%	100%	0%	Off	On	On
6am – 7am	0%	100%	100%	100%	0%	On	On	On
7am – 8am	0%	100%	100%	100%	0%	On	On	On
8am – 9am	0%	100%	100%	100%	0%	On	On	On
9am – 10am	0%	100%	100%	100%	0%	On	On	On
10am – 11am	0%	100%	100%	100%	0%	On	On	On
11am – 12pm	0%	100%	100%	100%	0%	On	On	On
12pm – 1pm	0%	100%	100%	100%	0%	On	On	On
1pm – 2pm	0%	100%	100%	100%	0%	On	On	On
2pm – 3pm	0%	100%	100%	100%	0%	On	On	On
3pm – 4pm	0%	100%	100%	100%	0%	On	On	On
4pm – 5pm	0%	100%	100%	100%	0%	On	On	On
5pm – 6pm	0%	100%	100%	100%	0%	On	On	On
6pm – 7pm	0%	100%	100%	100%	0%	On	On	On
7pm – 8pm	0%	15%	100%	100%	0%	Off	On	On

8pm – 9pm	0%	15%	100%	100%	0%	Off	On	On
9pm – 10pm	0%	15%	100%	100%	0%	Off	On	On
10pm – 11pm	0%	15%	100%	100%	0%	Off	On	On
11pm – 12am	0%	15%	15%	100%	0%	Off	Off	On

Profile	**When to use the different profiles**
Normal	When all work spaces in the building use the ‘Normal working day’ profile.
Long	When all workspaces in the building use either the ‘Normal working day’ or ‘Long working day’ profile.
24 hour	When one or more work spaces use the ‘24 hour work space’ profile.

External lighting

External lighting applications that would use these profiles include pathway lighting, decorative lighting, landscape lighting and external car park lighting, but excluding emergency lighting

	Lighting ‘normal’ (%)	Lighting ‘long’ (%)	Lighting ’24 hr’ (%)
12am – 1am	15%	15%	100%
1am – 2am	15%	15%	100%
2am – 3am	15%	15%	100%
3am – 4am	15%	100%	100%
4am – 5am	15%	100%	100%
5am – 6am	15%	100%	100%
6am – 7am	0%	0%	0%
7am – 8am	0%	0%	0%
8am – 9am	0%	0%	0%
9am – 10am	0%	0%	0%
10am – 11am	0%	0%	0%
11am – 12pm	0%	0%	0%
12pm – 1pm	0%	0%	0%
1pm – 2pm	0%	0%	0%
2pm – 3pm	0%	0%	0%
3pm – 4pm	0%	0%	0%
4pm – 5pm	0%	0%	0%
5pm – 6pm	0%	0%	0%
6pm – 7pm	100%	100%	100%
7pm – 8pm	15%	100%	100%
8pm – 9pm	15%	100%	100%
9pm – 10pm	15%	100%	100%
10pm – 11pm	15%	100%	100%
11pm – 12am	15%	15%	100%

Profile	When to use the different profiles
Normal	When all work spaces in the building use the ‘Normal working day’ profile.
Long	When all workspaces in the building use either the ‘Normal working day’ or ‘Long working day’ profile.
24 hour	When one or more work spaces use the ‘24 hour work space’ profile.

Appendix B. Definition of the Standard Practice Building HVAC System

The system must be of the type and description given in Section B1. The system shall meet the general HVAC system requirements specified in Section B2, and shall meet any system-specific requirements given in Section B3 that are applicable to the Standard Practice HVAC system type(s). All requirements give in Section J5 of the BCA must be met by the Standard Practice HVAC system.

The following guidance has been based on Appendix G of ASHRAE Standard 90.1-2007 Energy Standard for Buildings Except Low-Rise Residential Buildings (SI Edition)3, it has been modified by industry representatives to be appropriate for the Australian market.

Section			Description/requirement
B1	Standard Practice HVAC System Type and Description		The HVAC systems in the Standard Practice Building shall be based on the usage, number of floors, conditioned floor area and heating sources as specified in Table 1, and shall conform to the system descriptions in Table 2. For system (1), each thermal block shall be modeled with its own HVAC system. For systems (2) and (3), floors with identical thermal blocks can be grouped for modeling purposes. Spaces that have occupancy or process loads or schedules that differ significantly* from the rest of the building require separate single-zone systems conforming to the requirements of System 1. * Peak thermal loads that differ by 30% or more from the average of other spaces served by the system, or schedules that differ by more than 40 equivalent full load hours per week from other spaces served by the system are considered to differ significantly. (Modified from G3.1.1 ASHRAE 90.1-2007 (SI))
B2	General Standard Practice HVAC System Requirements		HVAC systems in the Standard Practice Building shall conform with the general provisions in this section.
	B2.1	Equipment Efficiencies	All equipment efficiencies in the Standard Practice Building design shall be modeled in accordance with BCA Section J.

---

[3] ASHRAE Standard 90.1-2007 (SI Edition) (ASHRAE, 2007) provides minimum requirements for the energy efficient design of buildings except low-rise residential buildings. This Standard is referenced by the building codes of the United States. Appendix G of this standard, however, is an 'informative' appendix. In other words, it is not officially part of the standard; rather it 'is intended for use in rating the energy efficiency of building designs that exceed the requirements of this standard'. It 'is provided for those wishing to use the methodology developed for this standard to quantify performance that substantially exceeds the requirements of [ASHRAE] Standard 90.1'

Section			Description/requirement
	B2.2	Equipment Capacities	The Standard Practice Building's HVAC plant shall be sized to meet the design criteria of the Standard Practice Building as given in Appendix A. The number of unmet load hours must be reported. It must be justified that the accuracy of the simulation is not significantly compromised by these unmet loads
	B2.3	Preheat coils	The Standard Practice HVAC system shall not be modeled with a preheat or precool coil, regardless of whether there is preheat or precool coil in the proposed design.
	B2.4	Fan system operation	Supply and return fan operation in the Standard Practice Building design shall be as required by the BCA Section J.
	B2.5	Economizers	The Standard Practice HVAC system shall include economy cycles where required by the BCA Section J.
	B2.6	Design Airflow Rates	System design supply airflow rates for the Standard Practice design shall be based on a supply-air-to-room-air temperature difference of 11°C or the required ventilation air or makeup air, whichever is greater. If return or relief fans are specified in the Proposed design, the Standard Practice design shall also be modeled with fans serving the same functions and sized for the Standard Practice system supply fan air quantity less the minimum outdoor air, or 90% of the supply fan air quantity, whichever is larger. (Clause G3.1.2.8, ASHRAE 90.1-2007 (SI))
	B2.7	System fan power	The system fan power of the Standard Practice system design shall be as required by the BCA Section J.
B3	System Specific Baseline HVAC System Requirements		Standard Practice Building HVAC systems shall conform with the provisions in this section, where applicable to the specified Standard Practice system types as indicated in the section headings.
	B3.1	Heat pumps (systems 1)	Electric air-source heat pumps shall be modeled with electric auxiliary heating. The systems shall be controlled with multistage space thermostats and an outdoor air thermostat wired to energize auxiliary heat only on the last thermostat stage and when out-door air temperature is less than 4°C. (Clause G3.1.3.1, ASHRAE 90.1-2007 (SI))
	B3.2	Hot water supply temperature (systems 2 and 3)	Hot-water design supply temperature shall be modeled as 80°C and design return temperature as 60°C. (Modified from G3.1.3.3 ASHRAE 90.1-2007 (SI))
	B3.3	Hot water pumps (systems 2 and 3)	The Standard Practice Design hot-water pump system shall meet all the requirements of the BCA.

Section			Description/requirement
	B3.4	Piping losses (systems 2 and 3)	If piping losses are modeled in the Proposed Building for hot water, chilled water or steam, the same loss factor must be included in the Standard Practice Design.
	B3.5	Type and number of chillers (System 2 and 3)	Electric chillers shall be used in the Standard Practice Design, regardless of the cooling energy source. Where the Standard Practice Building’s peak cooling load is less than 1,000kW, air cooled chillers are to be modeled. Where the peak cooling load is greater than 1,000kW water cooled chiller(s) are to be modeled. (Modified from G3.1.3.7 ASHRAE 90.1-2007 (SI)) The Standard Practice Design chiller(s) will have the minimum required COP(s) given in the BCA.
	B3.6	Chilled water design supply temperature (System 2 and 3)	Chilled-water design supply temperature shall be modeled at 6°C and return water temperature at 12°C. (Modified from G3.1.3.8 ASHRAE 90.1-2007 (SI))
	B3.7	Chilled water pumps (Systems 2 and 3)	The Standard Practice Design chilled-water pump system shall meet the requirements of the BCA.
	B3.8	Heat rejection (Systems 3)	For total cooling capacity greater than 1,000 kWr, the heat rejection device shall be an axial fan cooling tower with two speed fans. Condenser water design supply temperature shall be 29.5C or 5.5°C approaching design wet-bulb temperature, whichever is lower, with a ΔT or 5.5°C. (Modified from G3.1.3.11 ASHRAE 90.1-2007 (SI)) The Standard Practice Design fan power shall meet the requirements of the BCA.
	B3.9	VAV Minimum flow setpoints (System 2 and 3)	Minimum turndown ratio for VAV systems shall be modeled at 50%.
	B3.10	VAV Fan part-load performance (System 2 and 3)	VAV system supply fans shall have variable speed drives, and their part-load performance characteristics shall be modeled using either Method 1 or Method 2 given in Item 10 of Table 1: Modelling requirements for calculating the Proposed and Standard Practice Building energy consumption. (Clause G3.1.3.15 ASHRAE 90.1-2007 (SI)

Table 5: Definition of the Standard Practice Building HVAC System

Building Type	System Number	System type
Residential	(1)	Package/Split DX reverse cycle (heat pump) systems
Residential common areas	-	Not conditioned
Non-residential and < 2,300m^2	(1)	Package/Split DX reverse cycle (heat pump) systems
Non-residential > 2,300m^2 and less than 1,000 kWr total cooling capacity	(2)	Air cooled chillers
Non-residential and more than 1,000 kWr total cooling capacity	(3)	Water cooled chillers
Fire Stations	(1)	Package/Split DX reverse cycle (heat pump) systems

Table 6: Standard Practice HVAC System Types

System number	System type	Fan control	Cooling type	Heating type
(1)	Package/Split DX reverse cycle (heat pump) systems	Constant volume	Direct expansion	Electric heat pump
(2)	Air cooled chillers	Variable Speed Drive	Chilled water	Hot water fossil fuel boiler
(3)	Water cooled chillers	Variable Speed Drive	Chilled water	Hot water fossil fuel boiler

Table 7: Standard Practice System Descriptions

Appendix C. Energy Consumption Adjustment Factors

The purpose of this Appendix is to provide a method to reward potential energy savings from a range of system and controls initiatives, within the Energy Conditional Requirement and Ene-1: Greenhouse Gas Emissions.

The ‘adjustment factors’ provided, are estimates of potential energy savings; they are not based on measured or modelled data. It is the design team’s responsibility to select the most appropriate system and controls for the space and activity. These figures should not be used to justify the choice of system or controls. If the design team believe that these adjustment factors are rewarding less than optimum solutions, please contact the GBCA.

This Appendix includes energy consumption adjustment factors for;

- The installation of CO_2 monitoring and Variable Speed Drive (VSD) fans in car parks and loading docks
- Lighting zoning and automatic controls

Note: In order for the design team to use the adjustment factors provided in this Appendix, the design team must provide all the documentation requirements specifically identified in Chapter 4 Greenhouse Gas Emissions Modelling Report.

Energy Consumption Adjustment Factors for the installation of atmospheric contaminant monitoring and Variable Speed Drive (VSD) fans in car parks and loading docks

The adjustment factors provided in **Table 8**, are used to establish an ‘adjusted’ fan power rating as follows:

‘Adjusted’ fan power (W) = Proposed fan power (W)* x Adjustment factor for atmospheric contaminant monitoring and variable speed drive fans

The ‘adjusted’ fan power is then used with the appropriate Car park/loading dock HVAC profile (from Appendix A) to establish the annual energy use of the Proposed Building.

Requirement for adjustment factor	Adjustment factor
Car park and loading dock mechanical ventilation fans that include variable-speed drives controlled by atmospheric contaminant monitoring.	0.7

Table 8: Adjustment factor for atmospheric contaminant monitoring and variable speed drive fans

Energy Consumption Adjustment Factors (AFs) for Automatic Lighting Controls

The adjustment factors, provided in Appendix C., are used to establish an ‘Adjusted’ Illumination Power Density for the Proposed Building as follows: ‘Adjusted’ Proposed Building Illumination Power Density (W/m^2)	=	Proposed Building’s Illumination Power Density (W/m^2)*	x	Adjustment factor for proposed automated controls systems

* 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:

$$AF_{(combined)} = A \times (B + [(1-B) / 2])$$

Where:

- A is the lowest applicable illumination power density adjustment factor; and
- B is the second lowest applicable illumination power density adjustment factor.

The ‘Adjusted’ Illumination Power Density is then used with the standard lighting profile for the space type (from Appendix A) to establish the annual lighting energy use of the Proposed Building.

If your project includes automatic lighting controls that are not included in Appendix C approval to use specific alternative adjustment factors is required from the GBCA.

The difference between the Adjustment Factors used in Green Star and those used in the BCA

The Automatic Lighting Controls Adjustment Factors included in Appendix C, are based on the Illumination Power Density Adjustment Factors included in Section J6.2 of the BCA, with some amendments following consultation with lighting engineers. Both sets of Adjustment Factors (those from the BCA and those in this Appendix) have been created to acknowledge the energy savings of lighting controls initiatives. However they are used in different ways:

- The Adjustment Factors in Table J6.2 of the BCA are used to *increase* the maximum illumination power density allowable under the *Deemed-to-Satisfy* route to compliance.
- Green Star uses these adjustment factors to *decrease* the estimated energy consumption in the Proposed Building – they are not applied to the Standard Practice Building’s illumination power density.

This has been done to give the design team more flexibility in modelling energy savings from lighting controls strategies. For example, if the design team wishes to establish the energy savings from a particular controls strategy within the simulation software, such as for daylight dimming or occupancy sensors, they can do so by modelling the proposed lighting system rather than having to apply an inverse energy saving to the Standard Practice Building’s lighting energy consumption. **Note: If a project team wishes to use an alternative approach for establishing energy savings from lighting controls, they need to submit the methodology as a Credit Interpretation Request to the GBCA for approval.**

Item	**Requirement for the use of the Adjustment Factor**		**Adjustment Factor**
Motion detector in accordance with Specification J6	For all spaces within a building except for *'industrial spaces'* and car parks	Where an area of 200 m^2 or less is switched or dimmed as a block by one or more detectors	0.9 (If dimmed, see 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 2000m2, whichever is smaller. The minimum required block size is 200m2.	0.9 (If dimmed, see 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 (If dimmed, see Note 1)
		Where up to and including 2 lights are switched or dimmed as a block by one or more detectors.	0.55 (If dimmed, see Note 1)
	Car parks	Where an area of a car park of less than 500 m^2 is switched or dimmed as a block by one or more detectors.	0.7 (If dimmed, see Note 1)
Fixed dimming	Lighting is controlled by fixed dimmers that reduce the overall lighting level and the power consumption of the lighting. (Fixed dimming is where lights are controlled to a level and that level cannot be adjusted by the user.)		% of full power to which the dimmer is set.
Daylight sensor and dynamic lighting control device in accordance with Specification J6 – dimmed or stepped switching of lights adjacent windows	(a)	Lights within the space adjacent to windows other than roof lights for a distance from the window equal to the depth of the floor to window head height.	0.75 (Note 2 & 3)
	(b)	Where the total area of roof lights is less than 10% of the floor area, but greater than 5%.	0.8 (Note 2 & 3)
	(c)	Where the total area of roof lights is 10% or more of the floor area.	0.75 (Note 2 & 3)
	(d)	For spaces other than those described under (a), (b) and (c), where lighting is controlled by dynamic dimming (Dynamic dimming is where the lighting level is varied automatically by a photoelectric cell to proportionally compensate for the availability of daylight)	0.95 (Note 2 & 3)

Table 9. Adjustment Factors

* Where an individually addressable system is installed, the adjustment factor can be reduced by an additional 0.05.

Note 1: When the luminaires are not switched off, but are dimmed, the following equation must be used to create the ‘Dimmed’ Adjustment Factor applied to those luminaires:

$$AF_{(dimmed)} = \%AF_{(switched)} + (\%FP \times AF_{(switched)})$$

Where:

- $AF_{(dimmed)}$ is the adjustment factor that can be applied to dimmed luminaires
- $AF_{(switched)}$ is the adjustement factor that can be applied to switched luminaires
- %FP is the percentage of full power to which the dimmer falls when space is un-occupied

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

Note 3: These adjustment factors are conservative. If the design team believes that larger savings will be/are being realised, one of the two alternative methodologies should be used:

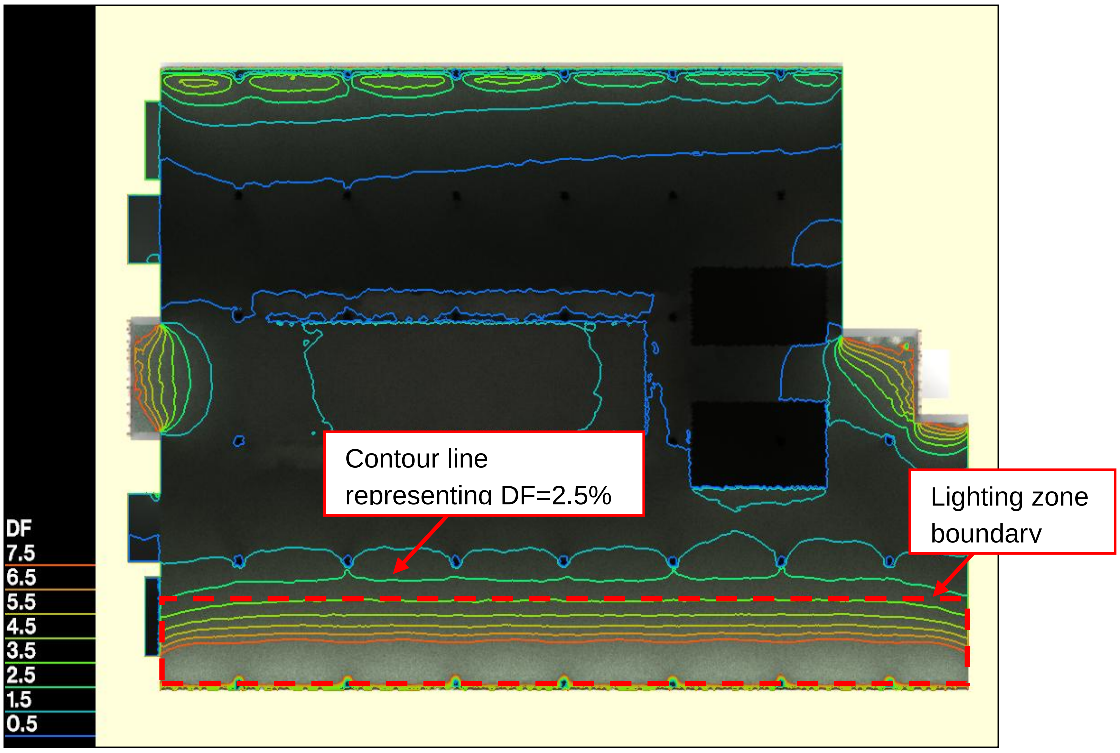
- The ‘Green Star protocol for calculating lighting energy reduction due to daylight dimming’ provided below; and
- Direct modelling of the operation of the sensors and luminaires in the building simulation.

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 GBCA through the standard CIR process before being used in the modelling process.

Green Star protocol for calculating lighting energy reduction due to daylight dimming

A worked example from Adelaide is included for reference. The lighting zone adjacent to the southern perimeter (floor area of 500m²) features daylight dimming, such that the light output from dimming ballasts is adjusted to maintain an illuminance of 320 lux. The lighting power density of the system (no dimming) is 8W/m².

1. Determine the minimum daylight factor achieved within the zone between 9am and 5pm, as measured at the working plane
    - For the modelled example, the minimum daylight factor (DF) achieved in the zone at the working plane is calculated to be 2.5%, as illustrated below



Contour line representing DF=2.5%

Lighting zone boundary

2. Determine the external horizontal illuminance, Eh, that must occur in order for an internal illuminance of 320 lux to be achieved at the working plane. The following formula applies:

$$\text{Eh} = \frac{\text{Ei}}{\text{Daylight factor}} \times 100\%$$

where:

Ei = interior illuminance at a point from a sky of assumed luminance distribution (lux)

Eh = the simultaneous external horizontal illuminance on an unobstructed horizontal plane from a sky of the same assumed luminance distribution (lux)

- For the modelled example, the minimum horizontal illumance, Eh, that must occur to achieve an internal illuminance, Ei, of 320 lux at the working plane is calculated to be 12.8klx as below

$$\begin{aligned} Eh &= \frac{Ei}{\text{Daylight factor}} \times 100\,\% \\ &= \frac{320}{2.5} \times 100\% \\ &= 12.8 \text{ klx} \end{aligned}$$

3. Determine the percentage of operational hours between 9am and 5pm for which this horizontal illuminance is exceeded, based on the table below

Percentage Working Year Illuminance is Exceeded	Diffuse Horizontal Illuminance (klx)						
	Sydney	Perth / Adelaide	Broken Hill	Brisbane	Mount Isa	Port Hedland	Darwin
Climatic Zone	Temperate	Temperate	Hot arid	Sub-tropical	Hot arid	Hot arid	Hot humid
Map Zone	3b	3b	2	1b	2	2	1a
100	0.0	1.3	0.0	0.0	8.0	4.2	7.6
95	6.3	7.0	4.6	4.7	9.3	6.7	10.8
90	8.8	8.8	5.9	7.9	10.2	7.5	12.7
85	10.6	9.7	6.6	8.8	11.1	7.9	13.3
80	11.3	10.5	7.2	9.4	11.4	8.4	14.8
75	13.3	11.1	7.6	10.1	11.9	8.6	16.1
70	14.5	11.9	8.0	11.0	12.3	8.8	17.8
65	16.1	12.6	8.4	12.8	12.7	9.1	19.0
60	18.4	14.2	8.7	15.8	13.2	9.4	19.8
55	19.9	15.8	9.1	19.0	13.8	9.7	21.3
50	22.0	17.2	9.6	21.0	14.7	10.1	23.1
45	23.3	18.1	10.2	22.4	16.0	13.2	24.4
40	24.1	18.9	12.9	23.8	17.9	15.2	25.2
35	26.7	20.2	14.7	25.9	19.2	16.8	26.4
30	28.2	21.2	16.5	27.3	20.4	17.7	27.9
25	30.2	22.3	17.4	29.7	21.7	19.3	29.6
20	32.4	23.7	21.0	31.8	23.0	20.2	31.5
15	34.3	25.1	23.2	34.0	24.9	22.3	32.4

10	36.9	26.8	27.4	37.1	26.0	24.1	34.4
5	39.4	29.5	32.5	40.7	28.3	28.8	37.8
0	44.9	53.7	39.6	51.0	44.0	49.0	43.0

Table 10. Diffuse Horizontal Illuminance (klx)

This table is sourced from “Skylight Availability in Australia – Data and their Application to Design” by N.C. Ruck PhD. Published by Illuminating Engineering Society of Australia, 2001.

Note that at this stage, this information is only available in a limited number of locations, and only between 9 and 5pm. The locations were chosen as being “representative of the major climatic zones on the Australian continent, together with their latitudes and climatic classification”. It is recommended that the closest location with the closest climatic zone of the project be chosen for this calculation (see figure below).

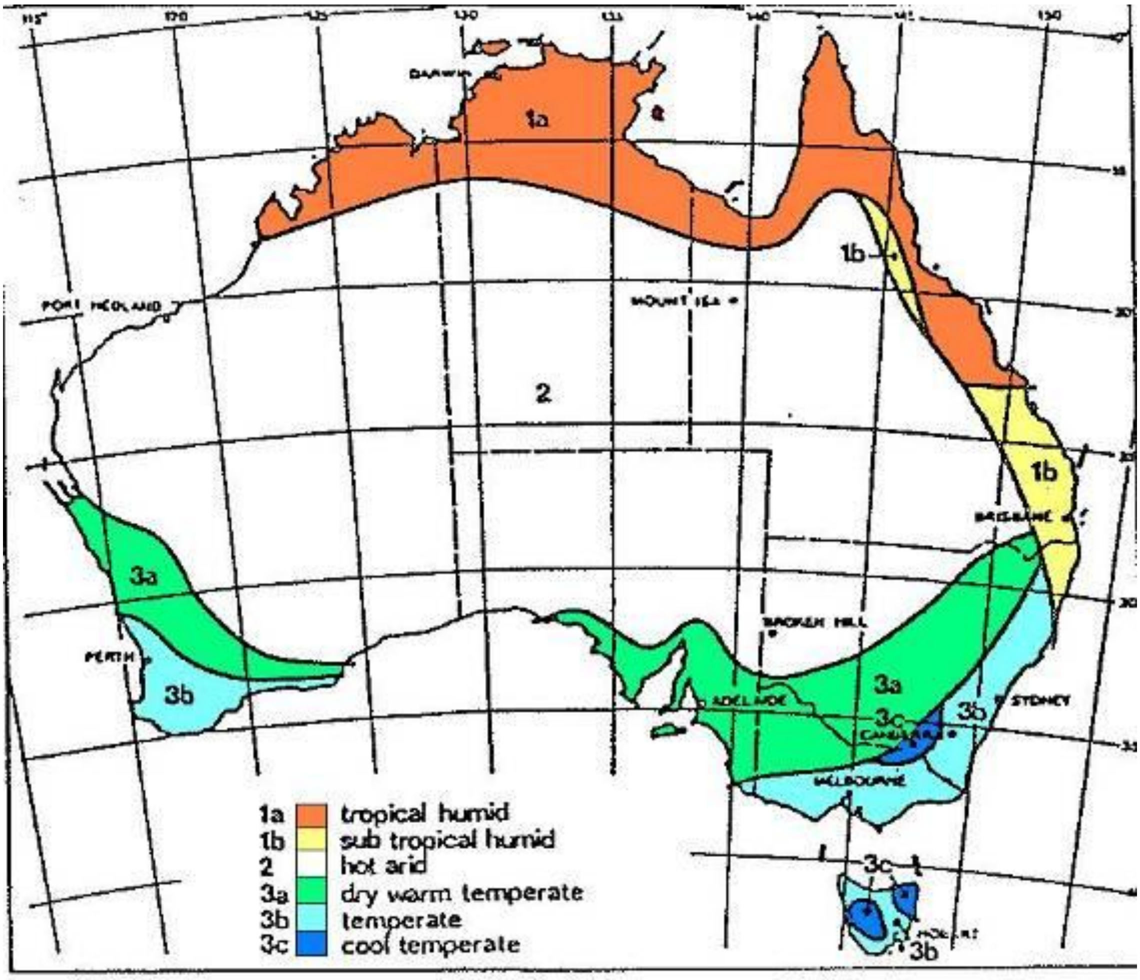


Figure 5 Map of climatic zones in Australia

- For the modelled example, from the lookup table provided, an external horizontal illuminance of 12.6klx is exceeded for 65% of hours between 9am and 5pm in Adelaide.

4. To obtain the lighting power density that should be modelled, multiply the lighting power density (no dimming) by the proportion of hours for which artificial lighting is required (i.e. for which 320lux daylight is not exceeded).

For the modelled example, the lighting power density would be: 8W/m² x 35% = 2.8W/m²

Appendix D. Lift energy consumption methodology

The formula which needs to be used to calculate the energy consumption by a lift per year, in kWh, is given below. This formula has been adapted for Green Star from the Draft ISO standard ISO/DIS 25745-1: Energy performance of lifts and escalators - Part 1: Energy measurement and conformance.

$$\text{Energy used by a lift per year (kWh):} = \frac{\text{Number of trips} \times \text{Average trip time (s)} \times \text{Average power load (kW)}}{3600} + \text{Standby power (kW)} \times \text{Standby hours per day} \times \text{Standby days per year}$$

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

Parameter	Definition	Proposed Building modelling requirements	Standard Practice Building modelling requirements
Number of trips	The standard number of trips per year for the relevant building type	The number of trips for the Proposed Building should be taken from **ng types** **peration** **Trips per** **week)**	As Proposed Building
Average trip time	The time, in seconds, for the lift to travel half the possible travel distance measured from doors closed to doors opening. The distance of average trip is 0.5×N. where: N is the total travel distance (m) of the lift. The lift can be assumed to run at the rated speed (m/s) over the whole trip.	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 distance travelled is the same as the Proposed Building. The rated speed of the Standard Practice Building lift is 1m/s
Average power load	The average power load is assumed to be the lift motor power rating (kW)	From supplier specifications for lift being assessed. This figure can be reduced by 20% if the lift has regenerative breaks.	40kW

Parameter	Definition	Proposed Building modelling requirements	Standard Practice Building modelling requirements
3600	The figure of 3600 converts the first half of the equation, which is in kWs, into kWh.		
Standby power	Standby power from car lights and lift control system in kW	From supplier specifications for lift being assessed	0.15kW
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 if the lift has a power off feature, 260 days should be used. Shopping centres and hospitals should use 365 days in all cases.	365 days

Table 11. Definition of parameters used to calculate the energy consumption of a lift

Lift Duty	**Trips per day**	**Building types (lift operation days/week)**	**Trips per year**		
			5 days/week (260 days/year)	6 days/week (312 days/year)	7 days/week (365 days/year)
Low	100	residential care (7), goods (5), library (6), entertainment centres (7)	26,000	31,200	36,500
Medium	300	office car parks (5), general car parks (7), residential (7), university (5), hotels (7), low rise hospitals (7), shopping centres (7)	78,000		109,500
High	750	office (5), airports (7), high rise hospitals (7)	195,000		273,750
Intensive	1000	HQ office (5)	260,000		365,000

Table 12. Number of trips

Gina Barney (2007)

Appendix E. Greenhouse gas emissions factors

Greenhouse gas emissions factors quantify the amount of greenhouse gas 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.

The greenhouse gas emission factors used in the Green Star – Public Building Greenhouse Gas Emissions Calculator are from the Australian Government's National Greenhouse Accounts (NGA) 2009, newer version may also be used by projects. Notes on the emissions factors used:

1. **The greenhouse gas emissions factors used include all direct and indirect emissions** (or Scopes 1, 2 and 3). Direct emissions include all greenhouse gases emitted directly from the site from the combustion of fuels. An example of a direct emission would be the emissions from a gas boiler or gas cook top. Indirect emissions include all emissions which occur off-site, but which result from the building's demand for energy. For example, indirect emissions include the emissions which occur at electricity power stations in order to supply the building with electricity, and the emissions which occur due to the extraction, transportation and fugitive losses of fuels, which the building or power station will ultimately consume.
2. **The emissions factors are given in terms of kilograms of carbon dioxide 'equivalent'** (kg/CO_2-e per unit of energy). This is because the emissions factor not only accounts for emissions from carbon dioxide, but from other significant greenhouse gases (which occur due to the combustion of fossil and bio-fuels) such as methane and nitrous oxide.
3. **Emissions factors for electricity and gas vary between states and territories.** For electricity, this is due to the mix of fuels used in the power stations. For gas, this is due to the variation in the fugitive emissions from the gas distribution network.
4. **The Scope 3 emissions factor for gas is the emissions factor for 'small users'.** Small users are defined as a user that consumes less than 100,000 gigajoules per year

State	Electricity (kgCO2-e /kWh)	Gas (kgCO2-e /MJ)	LPG (kgCO2-e /MJ)	Diesel (kgCO2-e /MJ)	Coal (kgCO2-e /MJ)	Solid Biomass (kgCO2-e /MJ)	Liquid Biofuels (kgCO2-e /MJ)
ACT	1.07	0.0655	0.0649	0.0748	0.0930	0.0018	0.0003
NSW	1.07	0.0655					
NT	0.77	0.0570					
QLD	1.02	0.0599					
SA	0.85	0.0617					
TAS	0.35	0.0570					
VIC	1.37	0.0553					
WA	0.92	0.0553					

Table 13: Greenhouse Gas Emissions Factors for all states and territories in Australia from National Greenhouse Accounts (NGA) Factors Workbook (DCC, 2009)

Appendix F. Leakage of synthetic gases

The methodology used to assess the contribution to the greenhouse gas emission from a building through leakage of synthetic gases is that given in the Australian Government's Department Of Climate Change document, National Greenhouse Accounts Factors 2009 (DCC, 2009).

Section 3.16 of the above mentioned document (Industrial processes — emissions of hydrofluorocarbons and sulphur hexafluoride gases), provides the following methodology:

$$E_{jk} = Stock_{jk} \times L_{jk}$$

Where:

- E_{jk} is the emissions of HFC, summed over each equipment type (tonnes of CO2-equivalent);
- $Stock_{jk}$ is the stock of HFC or SF6 contained in equipment, by equipment type (tonnes of CO2-e).; and
- L_{jk} is the default leakage rates by equipment type, as determined by Appendix F..

The leakage rates of synthetic gases for different types of equipment are given in Appendix F.

Equipment type	Default annual leakage rates of gas	
	HFCs	SF_6
Commercial air conditioning—chillers	0.09	
Commercial refrigeration - supermarket systems	0.23	
Industrial refrigeration including food processing and cold storage	0.16	
Gas insulated switchgear and circuit breaker applications		0.005

Table 14. Leakage rates for synthetic gases (Source: Table 25 from National Greenhouse Accounts Factors – June 2009 (DCC, 2009).)

Example: A calculation of emissions generated from the operation of a commercial chiller (Source: National Greenhouse Accounts Factors (DCC, 2009)

A company operates a commercial air conditioning-chiller, which contains 160 kg charge of HFC134a.

Convert HFC134a into a CO2-equivalent using the global warming potential of 1300 (from Appendix 1)

= 160 x 1300/1000
= 208 tonnes CO2-e

Applying the annual leakage rate of 0.09 (i.e. 9%) gives:

= 0.09 x 208

Total scope 1 GHG emissions = 19 tonnes CO2-e

Appendix G. Energy Modelling Summary Form

The following form must be filled in its entirety and submitted with all other required documentation at the time of assessment.

Contact and project details

Project name:	
GS number:	
Project Address:	
Simulator’s name:	
Organisation:	
Date:	

General information

Simulation program:	
Weather data:	
BCA Climate Zone:	
Number of storeys:	
Heating fuel source	
Cooling fuel source	

SPACE TYPE SUMMARY

Space type	Conditioned Area (m^2)	Unconditioned area (m^2)	Total area (m^2)
TOTAL:			

INPUTS: COMPARISON OF PROPOSED BUILDING AND STANDARD PRACTICE BUILDING INPUTS

	Modelling input parameter	Proposed Building	Standard Practice Building
Building form and envelope	Exterior above grade wall construction and U-value		
	Exterior below grade wall construction		
	Roof construction and U-value		
	Floor/slab construction and U-value		
	Window-to-gross wall ratio		
	Cold room/cool room construction and U-value		
	Fenestration type and U-value		
	Fenestration Solar Heat Gain Coefficient (South)		
	Fenestration Solar Heat Gain Coefficient (Non-South)		
	Fenestration Visual Light Transmittance		
	Fixed shading devices		
	Automated movable shading devices		
HVAC and hydraulic	Primary HVAC system type		
	Other HVAC system type		
	Design supply air temperature differential		
	Fan supply volume		
	Fan power		
	Economiser control		
	Demand control ventilation		
	Supplementary/Packaged Equipment Cooling Efficiency		
	Supplementary/Packaged Equipment Heating Efficiency		
	Chiller parameters (type, capacity and efficiency)		
	Cooling tower paramenters		

	Chilled water loop and pump parameters (static pressure (kPa) and flow rate(l/s))		
	Condenser water loop and pump parameters(static pressure (kPa) and flow rate(l/s))		
	Boiler parameters (Heating Hot Water).		
	Hot water loop and pump parameters (static pressure (kPa) and flow rate(l/s))		
Lighting	Interior Lighting Power Density (W/m^2) and lighting design description.		
	Daylighting controls		
	Occupant sensor controls		
	Other lighting controls		
Other	Does exterior lighting meet the horizontal lux requirement of AS 1158.3.1.?		
	Exterior lighting power density and controls		
	Domestic Hot Water fuel source		
	Domestic Hot Water system parameters (type, capacity, efficiency etc..)		
	Refrigeration system parameters (type, capacity, efficiency etc..)		
	Car park and other ventilation system parameters		
	Lifts		
	Other energy consumption		
	Swimming Pool		

ON-SITE ELECTRICITY GENERATION

Energy source	Backup energy type	Annual electricity generated (kWh)	Rated capacity

(Backup energy type = the fuel that is used when the renewable energy source is unavailable)

OUTPUTS: ADVISORY MESSAGES

Advisory messages	Proposed Building	Standard Practice Building	Difference
Number of hours of heating loads unmet			
Number of hours of cooling loads unmet			
Number of warnings			
Number of errors			
Number of defaults overridden			

OUTPUTS: THERMAL DEMAND SUMMARY FOR THE PROPOSED AND STANDARD PRACTICE DESIGNS

Thermal demand	Units of Annual Energy use and Peak Demand	Proposed Building	Standard Practice Building	Percent Saving
Chilled water loop	Total Annual chilled water loop thermal load (kWh/year)			
	Peak chilled water loop thermal demand (kW)			
Hot water loop	Total Annual hot water loop thermal load (kWh/year)			
	Peak hot water loop thermal demand (kW)			

OUTPUTS: ENERGY SUMMARY BY END USE FOR THE PROPOSED AND STANDARD PRACTICE DESIGNS.

End Use	Proposed Building energy type	Proposed Building Energy Use (kWh/year electricity or MJ/year fuel)	Standard Practice Building Energy Use (kWh/year electricity or MJ/year fuel)	Percent Saving
Interior lighting	Electricity			
Exterior lighting				
Space heating (fuel 1)				
Space heating (fuel 2)				
Space cooling				
Pumps				
Fans – interior				
Fans – car park				
Refrigeration				
Domestic Hot water (fuel 1)				
Domestic Hot water (fuel 2)				
Lifts				
Other energy consumption				
Swimming Pool				
TOTAL ANNUAL ENERGY USE	**ELECTRICITY**			
	GAS			
	Other (please enter)			

Proposed Building Electricity Production (kWh/year)

Electricity generation	

Appendix H. Methodology for estimating annaul energy consumption of swimming pools in Green Star

The energy consumption from a pool or spa should be calculated as follows:

Energy consumption from a pool or spa (kWh/yr)	=	Pumping energy (kWh/yr)	+	Heating energy (kWh/yr)	+	In-water lighting energy (kWh/yr)	+	Sanitising equipment energy (kWh/yr)	+	Timers and controls energy (kWh/yr)	+	Pool Hall Conditioning energy (kWh/yr)

- In the calculation of pumping energy, project teams must justify pump run times used in calculations with specifications of pump controllers. See below for more information.
- In the calculation of the heating energy, the efficiency of the heating system must be justified and the specification of the pool cover must be provided if there is one. See below for more information.
- All underwater pool lights must be included in this section. Note that:
  - External pool area lighting must be included in the external lighting section of the Greenhouse Gas Emissions calculator; and
  - Internal pool area lighting must be included in Amenities lighting section of the Greenhouse Gas Emissions calculator.
- The energy consumed by sanitising equipment, such as electrolytic cells in saltwater pools, ozone generators or dispensers for chlorine compounds must be accounted for. See below for more information.
- Energy consumption for all timers and controllers must be accounted for. See below for more information.

SAUNA ENERGY CONSUMPTION

Energy required by saunas must be justified by the design team with reference to the sauna volume, heating system, ventilation system and hours of operation.

The annual energy consumption of Swimming Pools is to be based on the guidance given in the Green Star – Multi-Uniit Residential tool, and is as follows:

MODELLING REQUIREMENTS

No.	**Element**	**Modelling Requirements**	
		Proposed Building	**Standard Practice Building**
1	Pool pump power	As per rated motor power of the actual system in the proposed design.	As Proposed Building model
2	Pool pump run hours	24 hours per day/ 365 days per year	As Proposed Building model
3	Pool Pump Efficiency	As per proposed system design.	8.0L/Wh (As per the Minimum Energy Performance Standard referenced in *AS5102.2-2009 Performance of household electrical*

			appliances – Swimming pool pump-units – Energy labellingand minimum energy performance standard requirements clause 3.3)
4	Pool pump energy (KWHrs)	Pump power (KW) x run hours(Hrs)	Pump power (KW) x run hours(Hrs)
5	Pool Heating system Energy required (KWh heating)	Utilise the Method described in Appendix B “Calculation of Pool Heating load” of AS3634-1989.	As Proposed Building model
6	Pool Heating system efficiency	As per proposed system design (i.e. heat pump, gas boiler, gas boosted heat pump, etc)	Gas pool heater with 70% efficiency (As per the Minimum Energy Performance Standard, in AS4560 Gas Pool heaters clause 5.81 states *The thermal efficiency of appliances operating at nominal gas consumption, shall be not less than 70%.*)
7	Pool heating system energy	Heating system Energy required(KWh) divided by plant efficiency (%) Where the water temperature is set down during night time, the energy requirement to be proportioned accordingly Further adjustment can made to the above run hours for installation of pool blanket.	Heating system Energy required(KWh) divided by plant efficiency (%) Where the water temperature is set down during night time, the energy requirement to be proportioned accordingly No adjustment for pool blankets are assumed for the standard practice buildings pool.
8	Pool heating energy adjustments	Adjustments to the pool heating system energy can be made as follows: - Pool blankets shall reduce the heating requirement to 10% of the design capacity when placed over the pool (Appendix C of AS 3634-1989). The operating times of the pool blanket to be clearly detailed in the design documents. Energy required to be proportioned for the times of the day the blanket shall be used.	No adjustments to be modelled for the standard practice building pool heating energy.
9	Sanitising equipment capacity (KW)	As per proposed system design	As Proposed Building model
10	Sanitising equipment run hours (Hrs)	24 hours per day/ 365 days per year	As Proposed Building model
11	Sanitising	Sanitising equipment power (KW) x run	Sanitising equipment power (KW) x run

	equipment energy (KWHrs)	hours(Hrs)	hours(Hrs)
12	Pool hall Environmental Conditions	- Space is conditioned to 1 degree above heated water temperature. - 100% outside air. - Ventilation rate of 8 air changes per hour. (as per ASHRAE (2007) Handbook – HVAC Applications for Natatoriums and in CIBSE Guide B 2001:2002 for the design of ventilation systems for pool halls) Where the pool water temperature is reduced overnight, the hall temperature shall maintain the 1 degree temperature difference.	As Proposed Building model
13	HVAC system type	The annual energy consumption for the proposed building's pool hall HVAC systems must be modelled on the basis of the proposed system with the daily profiles, heat gains and infiltration levels given below.	"The Standard Practice Building's HVAC system type and configuration must be as specified in Appendix B Definition of the Standard Practice Building HVAC System." For this particular instance the system type would be a type 1 DX Heat Pump.
14	HVAC system efficiencies	As per the actual systems in the proposed design.	The efficiencies of the type 1 system shall be as stipulated within the BCA Section J.
15	HVAC system capacities	As per the actual systems in the proposed design.	"The Standard Practice Building's HVAC plant shall be sized to meet the design criteria of the Standard Practice Building as given in Appendix A. The number of unmet load hours must be reported. It must be justified that the accuracy of the simulation is not significantly compromised by these unmet loads"
16	HVAC system fan power	As per the actual systems in the proposed design.	"The system fan power of the Standard Practice system design shall be as required by the BCA Section J."
17	HVAC system profile	24 hours per day/ 365 days per year as required to manage condensation and prevent build-up of chloramines in the occupied space	As Proposed Building model
18	Occupant Density Heat gains	1.5m2 of pool area per person(as per BCA Specification JV clause 2(a)(iii)(A). Moderate level of activity, in a hot environment, it is proposed to use 62	As Proposed Building model

		W/sqm Sensible and 188 W/sqm Latent as referenced in Table 45-Heat gain from People of AIRAH DA9 manual Profile as per 'Common area' profile given in Appendix A	
19	Equipment loads Heat gains	20W/m^2 to allow for heat gains due to operation of pumps	As Proposed Building model
20	Lighting loads Heat gains	The annual energy consumption from internal artificial lighting must be calculated on the basis of the proposed level of artificial lighting in the building with the 'common area' daily profiles given in Appendix A. Credit may be taken for lighting zoning and automatic controls in addition to those required for minimum code compliance. See Appendix C Energy Consumption Adjustment Factors	"Maximum illumination power used in theStandard Practice building must be as specified in the Deemed-to-Satisfy Provisions with the following allowance for Room Size: Required lighting levels must be as the Proposed Building. (BCA Section J, JV3 (d) (ii) (R)). The same profiles must be used as are used in the proposed building (given in - HVAC design parameters and occupancy and operational profiles). The Standard Practice Building's illumination power density can be increased by dividing it by the appropriate 'Room Size' illumination power density adjustment factor from Section J6.2 of the BCA. Note - the Standard Practice Building, is assumed to have no occupancy or daylight sensors; corridor timers; dimming systems; or dynamic lighting control devices in addition to what is required by the BCA (BCA Section J, JV3 (d) (i) (A &C)). Therefore no other adjustment factors can be applied to the Standard Practice Building."
21	Infiltration rates	Proposed Building infiltration values shall be consistent with the design documents and clearly justified. If unknown, Section J, JV3 (d)(i)(F)	"As BCA Section J, JV3 (d) (i) (F)."