green building council australia

Green Star – Education PILOT
Energy Calculator Guide

Prepared by: Advanced Environmental

PILOT

EXECUTIVE SUMMARY

The Green Star Education As Built Rating Tool has been developed to evaluate the predicted performance of education facilities based on a variety of environmental criteria. The Energy Credit Calculator within this tool will compare the predicted energy consumption of a education facility to a benchmark. This comparison will then be used to award points to any facility which improves on the benchmark.

To use the calculator the predicted energy consumption of the facility must be calculated. Important components of this calculation are the heating and cooling energy consumption of the facility, which must be determined using computer modelling. This guide specifies standard inputs to be used when modelling the heating, ventilation and cooling (HVAC) systems of the facility. The standard inputs include operational profiles and internal heat loads which facilitate comparison between different education facilities.

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

Finally, this guide includes information on how to enter the simulation outputs and the ancillary load calculations into the Education As Built Energy Credit Calculator. The calculator compares the performance of the facility relative to set benchmarks. Information on how these benchmarks were set can be found in The Education “Standard Practice” Benchmark document.

TABLE OF CONTENTS

LIST OF FIGURES

Issue/Status	Revision	Date Issued	Author	Checked	Approved	Comment
Draft for Review	A	October 2006	MA	MAT	MJ	Draft for TWG Revirew
Draft	B	November 2006	MA			Captures comments from the TWG

1 Introduction

The Green Building Council Australia (GBCA) has developed a suite of rating tools to assess the environmental performance of buildings in Australia. As part of this package, the Green Star Education As Built Rating Tool assesses the environmental performance of education facilities by measuring their environmental impact.

Part of this assessment of environmental performance includes determining the predicted energy consumption of a education facility. The Education Energy Credit Calculator has been developed to compare this to a benchmark. More information on how the benchmarks were set can be found in The Education “Standard Practice” Benchmark document.

The building must be simulated using computer modelling software in order to determine the predicted energy consumption of its Heating, Ventilation and Cooling (HVAC) system. In addition, the predicted energy consumption of the ancillary loads in the building must be calculated.

This report has been written as a guide to these calculations, and how they should be entered into the Energy Calculator for comparison.

2 Guidelines for Simulation Input Parameters

The parameters used to simulate the HVAC energy consumption of a education facility is given in this section. These are standard criteria that must be adhered to in ordered to comply with the Green Star energy credit requirements. The outputs from this simulation will then be entered in the calculator, as outlined in Section 4.

If a common central plant is shared by the rated development and another building or space, the central plant must be treated as follows:

1) The size of the central plant used for the energy calculations in this rating tool must be assumed as equivalent to the peak demand of the development to be rated;
2) The part load curves for the actual central plant shall be applied proportionally to the central plant used for the energy calculations.

2.1 General Parameters

	Modelling Parameter	Requirements	Documentation
GENERAL	Simulation Package	• Passed the BESTEST[1] validation test; or • The European Union draft standard EN13791 July 2000; or • Be certified in accordance with ANSI/ASHRAE Standard 140-2001. Please contact the Green Building Council of Australia if none of the above options can be complied with.	<u>Energy Report:</u> • Simulation brief for assessor (see Appendix A).

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

	Weather Data	• A Test Reference Year (TRY) if the building location is within 50km of a TRY location; or • In the absence of local TRY weather data, an actual year of recorded weather data from a location within 50km of the building location; or • In the absence of TRY or actual weather data within 50km, interpolated data based upon 3 points within 250km of the building location. Please contact the Green Building Council of Australia if none of the above options can be complied with.	Energy Report: • Type of data (TRY / year / interpolated). • Weather station location.
	Over - shadowing	• Demonstrate that overshadowing from the surrounding environment has been taken into account in the model.	Verification Documents: • Relevant architectural drawings. Energy Report: • Details of how overshadowing from the external environment has been represented in the model.

Table 1: General Parameters Table

2.2 Building Envelope

	Modelling Parameter	Requirements	Documentation
	Building Form	• Demonstrate that the simulation model is an accurate representation of the building's shape; • Demonstrate that all floors in the building are modelled; and • Show that there are limited simplifications to the building form.	Verification Documents: • Relevant architectural drawings. Energy Report: • Details of how the building's physical shape has been represented in the model. • Details of any simplifications in the model and their effect.
	Insulation	• Demonstrate that insulation in the walls, ceiling and floors has been accurately represented.	Verification Documents: • Relevant architectural drawings. • Materials schedule. Energy Report: • Details on how the insulation has been represented in the model.
	Glazing	• Demonstrate that glazing is modelled using the following parameters: • Visible light transmission; • Solar transmission; • Internal and external solar reflectance; and • Emissivity.	Verification Documents: • Relevant pages from the glazing or façade specification. Energy Report: • Details of how glazing has been modelled.

	Windows and Spandrel	• Demonstrate that the sizes of windows and spandrel are accurately represented.	Verification Documents: • Relevant architectural drawings. Energy Report: • Details of the window and spandel sizes that have been used in the model.
	Shading	• Demonstrate that all shading of windows and external building fabric has been accurately represented.	Verification Documents: • Relevant architectural drawings. Energy Report: • Details of how window shading and external building fabric are represented in the model.
	Orientation	• Demonstrate that the building orientation has been included in the model.	Verification Documents: • Relevant architectural drawings. Energy Report: • Details of how the orientation has been represented in the model.
	Infiltration	• Demonstrate that infiltration has been modelled to reflect façade design specification. Typical default values are 0.5 air changes per hour for perimeter zones and zero air changes per hour for central zones.	Verification Documents: • Relevant architectural drawings. • Relevant pages from the façade specification that show infiltration or façade sealing characteristics. Energy Report: • Details of how infiltration has been modelled.

Table 2: Building envelope parameters

2.3 Internal Loads

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

	Occupancy	• Demonstrate that all occupancies are calculated based on floor area. • Demonstrate that the occupancy profile used is that prescribed for each space type in Appendices C and D.	<u>Verification Documents:</u> • Area schedule. <u>Energy Report:</u> • Details of space type areas using the definitions in Appendix B • Details on how the occupancy loads have been modelled • Details on the profiles used for occupancy

Table 3: Internal loads parameters

2.4 A/C Pumping

	Modelling Parameter	Requirements	Documentation
A/C PUMPING	Chilled water	• Demonstrate that chilled water pumping is calculated using the building cooling load, the static pressure of the chilled water pumps (typically 250kPa) and the flow rate in L/s.	<u>Verification Documents:</u> • Relevant pages from the hydraulic and mechanical specifications showing chilled water pump data – static pressure and flow rate in L/s. <u>Energy Report:</u> • Calculation of chilled water pumping.
	Heating hot water	• Demonstrate that the hot water pumping is calculated using the building heating load, the static pressure of the hot water pumps (typically 250kPa) and the flow rate in L/s.	<u>Verification Documents:</u> • Relevant pages from the hydraulic and mechanical specifications showing hot water pump data – static pressure and flow rate in L/s. <u>Energy Report:</u> • Calculation of hot water pumping.
	Tenant condenser water	• If a tenant condenser water loop is provided, show that allowance has been made for the additional energy used for tenant supplementary condenser water pumping. • If relevant, demonstrate that the tenant condenser water loop pumping is calculated based on a tenant supplementary cooling load, the static pressure of the tenant condenser water pumps (typically 250kPa) and the flow rate in L/s.	<u>Verification Documents:</u> • Relevant pages from the hydraulic and mechanical specifications showing the tenant water condenser loop data (or lack thereof); static pressure and the flow rate in L/s. <u>Energy Report:</u> • If relevant, details on how the tenant condenser water loop pumping was calculated.

Table 4: A/C pumping parameters

2.5 HVAC System Simulations

	Modelling Parameter	Requirements	Documentation
HVAC System Simulation	HVAC System design	• Demonstrate that the HVAC system modelled represents the system design for each part of the building.	<u>Verification Documents:</u> • Relevant pages from mechanical specification and mechanical drawings which accurately and thoroughly describe the basic HVAC system design. <u>Energy Report:</u> • Details of how the HVAC system has been represented in the model.
	Zoning	• Demonstrate that all air conditioning zones represented in the thermal model accurately reflect system performance and zonal solar diversity.	<u>Energy Report:</u> • Details of how the air conditioning zones have been represented in the model, and how these zones accurately represent the mechanical design drawings and specification.
	Chiller plant	• Demonstrate that the chiller plant size is accurately reflected in the model. • Demonstrate that the actual efficiency curves of the installed plant are used in the model. • <u>Water cooled equipment:</u> Demonstrate that chiller data is specified under conditions that reflect the intended condenser water temperature controls. • <u>Air cooled equipment:</u> Demonstrate that the air cooled chiller COP profiles have been accurately modelled with regard to loading and ambient conditions	<u>Verification Documents:</u> • Relevant pages from the mechanical specification showing the chiller plant size and any condenser water operation. • Documentation from chiller supplier giving part load curves (and condenser water temperatures where applicable). <u>Energy Report:</u> • Details of how the chiller plant size has been represented in the model. • Details of how the actual efficiency curves have been used in the model. • Details of how the chiller data is relevant to the intended condenser water temperature controls.

	Boiler plant	• Demonstrate that the boiler plant size, thermal efficiency and distribution efficiency are accurately reflected in the model.	Verification Documents: • Relevant pages from the mechanical specification which show details of the boiler plant size, thermal efficiency and distribution efficiency. Energy Report: • Details of how the boiler has been modelled.
	Supply Air and Exhaust Fans	• Demonstrate that fan performance curves are accurately represented in the model. • Demonstrate that index run pressure drops are accurately represented to include the total static inclusive of filters, coils and diffusers.	Verification Documents: • Pages from the mechanical specification showing fan performance curves and fan size. Energy Report: • Details of how the index run pressure drops have been calculated. • Details of how these have been modelled.
	Cooling Tower Fans	• Demonstrate that allowance for energy consumption from cooling tower fans has been made, based upon the annual cooling load of the building and the supplementary cooling load for tenancy air conditioning.	Energy Report: • Details of how the cooling tower fans have been modelled.
	Cooling Tower and Condenser Water Pumping	• Demonstrate that allowance for energy consumption from cooling tower and condenser water pumping has been made, based upon the annual cooling load of the building.	Energy Report: • Details of how the cooling tower and condenser water pumping have been modelled.

Table 5: HVAC system simulation

2.6 HVAC Controls

	Modelling Parameter	Requirements	Documentation
HVAC Controls	Outside Air	• Demonstrate that outdoor air flows have been modelled as documented in the mechanical design drawings and specifications, and in compliance with the appropriate standards.	Verification Documents: • Relevant pages from mechanical specification giving details on the correct minimum outside air flow Energy Report: • Detail of how outside air flow has been represented in the system
	Economy Cycle	• Demonstrate that economy cycles have been modelled to reflect system specification noting any enthalpy/temperature cut-off and control point.	Verification Documents: • Relevant pages from mechanical specification giving details on the economy cycle of the system Energy Report: • Detail of how the economy cycle has been modelled
	Primary duct temperature control	• Constant Volume Systems: Demonstrate that modelling has allowed supply air temperatures to vary to meet loads in the space • Variable Volume Systems: Demonstrate that modelling has allowed supply air volumes to vary to meet loads in the space • Demonstrate that setpoints have been rescheduled as specified. Note that simplifications may be made to consider average zone temperature in lieu of high/low select.	Verification Documents: • Relevant pages from mechanical specification giving details of the design temperature and HVAC cooling and heating setpoints Energy Report: • Detail of how design temperatures and setpoints have been modelled

	Airflow Control	• Demonstrate that control logic describing the operation of the dampers to control outside and re-circulated airflow is inherent in the model and accurately reflects the airflow characteristics of the system.	Verification Documents: • Relevant pages from the mechanical specification giving details of the operation of the dampers to control outside and recirculated air Energy Report: • Details of how these have been represented in the model
	Minimum turndown	• Demonstrate, where relevant, that the minimum turndown airflow of each air supply is accurately reflected in the model.	Verification Documents: • Relevant pages from the mechanical specification giving details of the minimum turndown airflow of each air supply Energy Report: • Details of how the minimum turndown is modelled for each air supply
	Chiller staging	• Demonstrate that for systems that employ multiple chillers with a chiller staging strategy, the correct controls are modelled to reflect the actual relationship between the chillers.	Verification Documents: • Relevant pages from the mechanical specification giving details of the chiller staging strategy Energy Report: • Details of how chiller staging has been modelled
	Temperature control bands	• Demonstrate that the temperature control bands of the system accurately reflect the thermal model.	Verification Documents: • Relevant pages from the mechanical specification giving details of the design specification for the thermal model Energy Report: • Details of how the temperature control bands have been modelled

Table 6: HVAC Controls parameters

3 Ancillary Services

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

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

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

	Modelling Parameter	Requirements	Documentation
Ancillary Services	Domestic hot water loads	• Domestic hot water loads (to showers and wash hand basins) are to be calculated using the method outlined in Appendix E. • Note that any other hot water supply (such as for laundries) is not to be included.	Verification Documents: • Area schedule • Specification of domestic hot water systems Energy Report: • Details of how the domestic hot water heating energy requirement is calculated in accordance with Appendix E.
	Lift loads	• Lift loads are to be calculated using the method outlined in Appendix E.	Verification Documents: • Area schedule • Specification of lift systems Energy Report: • Details of how the lift energy requirement is calculated in accordance with Appendix E.

	Escalator and travelator loads	• Escalator and travelator loads are to be calculated using the method outlined in Appendix E.	Verification Documents: • Area schedule • Specification of escalator and travelator systems Energy Report: • Details of how the escalator and travelator energy requirement is calculated
	Lighting	• Demonstrate that lighting is calculated based on floor area. • Demonstrate that the appropriate Lighting Energy Consumption Profile in Appendix C has been used. The lighting profile can be adjusted if the following are installed: • Occupancy sensors: Lighting must follow the appropriate lighting profile whenever the appropriate occupancy profile is larger than 0. • Time Clocks: If lighting operates on a time clock then common area lighting must follow the appropriate lighting profile when specified as "on" by the electrical specification. This must operate for no less time than described for the previous point. • Daylight dimming: Details on this system must be provided	Verification Documents: • Area schedule • Reflected ceiling plans with base building lighting design • Relevant pages from electrical specification showing occupancy sensors (if any), time clock (if any), lights and light fittings Energy Report: • Details of space type areas using the definitions in Appendix B • Details of how the lighting power densities have been modelled • Details of how the operational profiles for the building have been modelled • Details of the lighting control systems and how they have been modelled
	Mechanical exhaust systems	• Demonstrate that the energy requirements for mechanical exhaust systems (such as those installed for toilets, kitchens and any other purpose specific systems such as photocopy or computer server room exhausts) are calculated using the following parameters: • Maximum power of the fan; • 50% fan efficiency; and • An operational profile based on the operational profiles. That is, the fan should be on anytime that the HVAC system is on.	Verification Documents: • Relevant pages from the mechanical specification showing details of mechanical exhaust systems. Energy Report: • Details of how the energy requirements for mechanical exhaust systems are calculated.

Table 7: Ancillary services parameters

4 Guidelines for simulation outputs

This diagram shows how to enter the simulation outputs into the Education As Built Rating Tool Energy Credit Calculator. Information should be entered into the white cells.

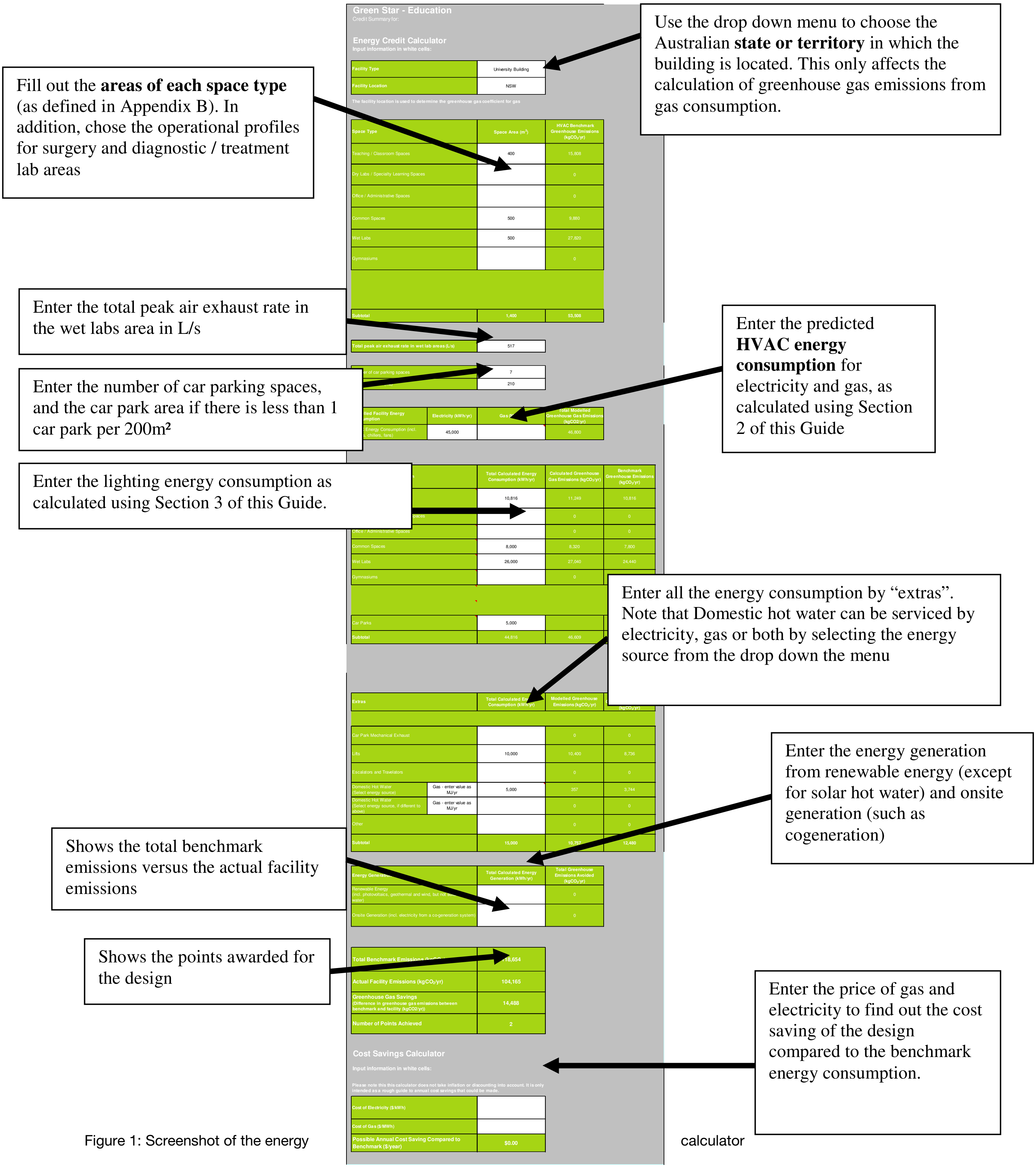

Figure 1: Screenshot of the energy calculator

5 Case Study – On-site Energy Generation

This case study illustrates how cogeneration and solar hot water energy generation are captured within the calculator

The case study education facility has 25,000m² of teaching and classroom spaces area and 5,000m² of dry labs and specialty learning areas. It is located in NSW and generates electricity on site using cogeneration, solar hot water and renewable energy.

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

Space Type	Area (m²)
Teaching / Classroom Spaces	25,000
Dry Labs / Specialty Learning Spaces	5,000
Office / Administrative Spaces	100
Common Spaces	500

Table 8: Space Type Areas for case study

Next, the HVAC consumption of electricity and gas is calculated using Section 2 of this Guide. Note that in this case gas consumption is only used to fire the cogeneration plant on site. In other systems, gas used in the HVAC system should also be included here.

Energy Source	Energy Consumption (kWh/year)
Electricity	7,000,000
Gas	100,000

Table 9: HVAC Energy Consumption for case study

The lighting energy consumption is calculated using Section 3 of this Guide. Domestic hot water in this case is serviced by solar hot water, so no energy from gas or electricity is used.

Item	Energy Consumption (kWh/year)
Teaching / Classroom Spaces Lighting	600,000
Dry Labs / Specialty Learning Spaces Lighting	100,000
Office / Administrative Spaces Lighting	5000
Common Spaces Lighting	10,000
Lifts	200,000
Domestic Hot Water	0

Table 10: Lighting and Equipment Energy Consumption

Finally the onsite energy generation is calculated. Note that the solar hot water energy generation is not included here as it has already been included in the table above. The electricity produced from the cogeneration plant however, is included here as it has not been accounted for as yet. In addition, 1000kWh of photovoltaic energy is included here.

On-site energy generation	Energy generation (kWh/year)
Renewable Energy (incl. Photovoltaics, Geothermal and Wind, but not solar hot water)	1,000
Onsite Generation (incl. Electricity from a co-generation system)	25,000

Table 11: On-site energy generation

This information is entered into the calculator as detailed below.

Green Star - Education
Credit Summary for:

Energy Credit Calculator
Input information in white cells:

Facility Type	University Building
Facility Location	SA

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

Space Type	Space Area (m^2)	HVAC Benchmark Greenhouse Emissions ($kgCO_2/yr$)
Teaching / Classroom Spaces	25,000	988,000
Dry Labs / Specialty Learning Spaces	5,000	228,800
Office / Administrative Spaces	100	2,600
Common Spaces	500	9,880
Wet Labs	100	5,524
Gymnasiums	0	0
Subtotal	30,700	1,234,804

Total peak air exhaust rate in wet lab areas (L/s)	517
Number of car parking spaces	0

Modelled Facility Energy Consumption	Electricity (kWh/yr)	Gas (MJ/yr)	Total Modelled Greenhouse Gas Emissions (kgCO2/yr)
HVAC Energy Consumption (incl. boilers, chillers, fans)	1,000,000	100,000	1,047,380

Lighting Energy Consumption	Total Calculated Energy Consumption (kWh/yr)	Calculated Greenhouse Gas Emissions ($kgCO_2/yr$)	Benchmark Greenhouse Emissions ($kgCO_2/yr$)
Teaching / Classroom Spaces	600,000	624,000	676,000
Dry Labs / Specialty Learning Spaces	100,000	104,000	135,200
Office / Administrative Spaces	5,000	5,200	3,700
Common Spaces	10,000	10,400	7,800
Wet Labs	4,000	4,160	4,888
Gymnasiums		0	0
Subtotal	719,000	747,760	827,588

Extras		Total Calculated Energy Consumption (kWh/yr)	Modelled Greenhouse Emissions ($kgCO_2/yr$)	Benchmark Greenhouse Emissions ($kgCO_2/yr$)
Lifts		200,000	[illegible]	191,568
Escalators and Travelators			0	0
Domestic Hot Water (Select energy source)	Gas - enter value as MJ/yr	0	0	126,672
Domestic Hot Water (Select energy source, if different to above)	Gas - enter value as MJ/yr		0	0
Other			0	0
Subtotal		200,000	208,000	318,240

If domestic hot water is supplied by gas or electricity, then the energy consumption should be entered here. This includes any gas or electric boosting of solar hot water systems. If domestic hot water is solely supplied by solar thermal then no value should be entered.

Energy Generation	Total Calculated Energy Generation (kWh/yr)	Total Greenhouse Emissions Avoided ($kgCO_2/yr$)
Renewable Energy (incl. photovoltaics, geothermal and wind, but not solar hot water)	1,000	
Onsite Generation (incl. electricity from a co-generation system)	25,000	26,000

Any on-site generation should be entered here. This includes electricity generated from co-generation and from renewables such as Photovoltaics. This does not however, include energy generated from solar hot water.

Total Benchmark Emissions ($kgCO_2/yr$)	2,380,632
Actual Facility Emissions ($kgCO_2/yr$)	1,976,100
Greenhouse Gas Savings (Difference in greenhouse gas emissions between benchmark and facility (kgCO2/yr))	404,532
Number of Points Achieved	3

Figure 2: Entry of case study into the calculator

APPENDIX A – SIMULATION BRIEF FOR ASSESSORS

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

- The simulation package has passed external validation standards such as BESTEST[2];
- The model analyses building performance on an hourly basis for a full year;
- The model accurately represents:
    - The proposed HVAC system;
    - The HVAC controls which are to be used;
    - Glazing on the building – whether the model represents glazing as only a U-value and shading coefficient;
    - The performance curves and sizes for plant items;
    - The daylighting effects and the operation of daylight controls; and
- All other aspects of the building have been modelled correctly, with no significant compromises made.

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

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

APPENDIX B: SPACE TYPE DEFINITIONS

The following provides definitions of the space types used within the Education As Built Energy Credit Calculator.

Primary and High Schools

Classroom / Multipurpose Spaces – These spaces include lecture theatres, classrooms, seminar rooms, tutorial rooms, studios and multipurpose general areas

Computer and Physics Labs – These spaces include: dry teaching labs (e.g. physics without high service requirements), light workshops (without heavy machinery) and computer labs

Office and Staff Rooms –These spaces include offices and meeting rooms.

Libraries – These spaces include library areas, where reading and listening resources are kept for teaching and lending purposes. These areas may also include limited computer facilities.

Common Spaces – These spaces include: foyers, amenities, passages, corridors and circulation.

Canteen – These spaces include areas which are primarily used for the preparing and selling of food during morning tea and lunch breaks. These may also be known as a kiosk.

Workshops – These spaces are similar to computer and physics labs, except that they include heavy machinery.

Gymnasiums – These spaces primarily include indoor sports halls, such as basketball courts, but may also include small areas with weight lifting equipment.

Car Parks - These spaces include areas specifically designated for car parking.

University Buildings

Teaching and Learning Spaces – These spaces include lecture theatres, classrooms, seminar rooms, tutorial rooms, studios, libraries and multipurpose general areas

Dry Labs and Specialty Learning Spaces –These spaces include: dry teaching labs (e.g. physics without high service requirements), light workshops (without heavy machinery) and computer labs

Office Administrative Space – These spaces include offices, meeting rooms, conference facilities and libraries

Common Spaces – These spaces include: foyers, amenities, passages, corridors and circulation.

Wet Labs – These spaces include wet laboratories (such as chemical and bioscience), heavy workshops (those that contain equipment that utilizes significant services), food service areas, home economics labs and specialty medical and dental areas.

Gymnasiums – These spaces include professional indoor gymnasiums with weight lifting and cardiovascular equipment and indoor sport halls, such as basketball courts.

Car Parks - These spaces include areas specifically designated for car parking.

APPENDIX C: PRIMARY / HIGH SCHOOL PROFILES

Classroom / Multipurpose Space

Note: When calculating the HVAC energy consumption of these spaces, the model should use the specified lighting densities in the HVAC Model Operational Profile. When calculating the energy consumption of the lighting in the facility, the lighting profile should be used in conjunction with the lighting densities as per the lighting specifications.

Input

Upper Temperature Limit: 27°C
Lower Temperature Limit: 20°C
Air change rate: In accordance with AS1668.2 or engineered design

HVAC Model Operational Profile

Weekdays						
Time	Occupancy Gains (W/m²)		Occupancy (m²/person)	Lighting (W/m²)	Equipment (W/m²)	Plant Operation
	Sensible	Latent				
12am	0	0	0	0.5	0.25	Off
1am	0	0	0	0.5	0.25	Off
2am	0	0	0	0.5	0.25	Off
3am	0	0	0	0.5	0.25	Off
4am	0	0	0	0.5	0.25	Off
5am	0	0	0	0.5	0.25	Off
6am	0	0	0	0.5	0.25	Off
7am	1	1	80	3	4.25	On
8am	1	1	80	3	4.25	On
9am	6	5	12	10	5	On
10am	6	5	12	10	5	On
11am	6	5	12	10	5	On
12am	3	3	24	8	3.5	On
1pm	6	5	12	10	5	On
2pm	6	5	12	10	5	On
3pm	6	5	12	10	5	On
4pm	6	5	12	10	5	On
5pm	1	1	80	3	1.5	Off
6pm	1	1	80	3	1.5	Off
7pm	0	0	0	0.5	0.25	Off
8pm	0	0	0	0.5	0.25	Off
9pm	0	0	0	0.5	0.25	Off
10pm	0	0	0	0.5	0.25	Off
11pm	0	0	0	0.5	0.25	Off

Table 12: Classroom / multipurpose space

Lighting Energy Consumption Profile

Time	Artificial Lighting
0000-0600	5%
0600-0700	30%
0700-0900	100%
0900-1200	80%
1200-1600	100%
1600-1800	30%
1800-2400	5%

Table 13: Classroom / multipurpose lighting energy consumption profile

Computer / Physics Labs

Note: When calculating the HVAC energy consumption of these spaces, the model should use the specified lighting densities in the HVAC Model Operational Profile. When calculating the energy consumption of the lighting in the facility, the lighting profile should be used in conjunction with the lighting densities as per the lighting specifications.

Input

Upper Temperature Limit: 24°C
Lower Temperature Limit: 21°C
Air change rate: In accordance with AS1668.2 or engineered design

HVAC Model Operational Profile

Weekdays						
Time	Occupancy Gains (W/m^2)		Occupancy (m^2/person)	Lighting (W/m^2)	Equipment (W/m^2)	Plant Operation
	Sensible	Latent				
12am	0	0	0	0.5	1.35	Off
1am	0	0	0	0.5	1.35	Off
2am	0	0	0	0.5	1.35	Off
3am	0	0	0	0.5	1.35	Off
4am	0	0	0	0.5	1.35	Off
5am	0	0	0	0.5	1.35	Off
6am	0	0	0	0.5	1.35	Off
7am	3	3	27	3	22.95	On
8am	3	3	27	3	22.95	On
9am	18	15	4	10	27	On
10am	18	15	4	10	27	On
11am	18	15	4	10	27	On
12am	9	8	8	8	18.9	On
1pm	18	15	4	10	27	On
2pm	18	15	4	10	27	On
3pm	18	15	4	10	27	On
4pm	18	15	4	10	27	On
5pm	3	3	27	3	8.1	Off
6pm	3	3	27	3	8.1	Off
7pm	0	0	0	0.5	1.35	Off
8pm	0	0	0	0.5	1.35	Off
9pm	0	0	0	0.5	1.35	Off
10pm	0	0	0	0.5	1.35	Off
11pm	0	0	0	0.5	1.35	Off

Table 14: Computer / Physics Labs

Lighting Energy Consumption Profile

Time	Artificial Lighting
0000-0600	5%
0600-0700	30%
0700-0900	100%
0900-1200	80%
1200-1600	100%
1600-1800	30%
1800-2400	5%

Table 15: Computer / Physics Labs lighting energy consumption profile

Office and Staff Rooms

Note: When calculating the HVAC energy consumption of these spaces, the model should use the specified lighting densities in the HVAC Model Operational Profile. When calculating the energy consumption of the lighting in the facility, the lighting profile should be used in conjunction with the lighting densities as per the lighting specifications.

Input

Upper Temperature Limit: 24°C
Lower Temperature Limit: 21°C
Air change rate: In accordance with AS1668.2 or engineered design

HVAC Model Operational Profile

Weekdays						
Time	Occupancy Gains (W/m²)		Occupancy (m²/person)	Lighting (W/m²)	Equipment (W/m²)	Plant Operation
	Sensible	Latent				
12am	0	0	0	1	1.1	Off
1am	0	0	0	1	1.1	Off
2am	0	0	0	1	1.1	Off
3am	0	0	0	1	1.1	Off
4am	0	0	0	1	1.1	Off
5am	0	0	0	1	1.1	Off
6am	0	0	0	1	1.1	Off
7am	1	1	260	4	2.75	On
8am	2	1	65	8	7.7	On
9am	2	2	39	10	11	On
10am	2	2	39	10	11	On
11am	2	2	39	10	11	On
12am	2	2	39	10	11	On
1pm	2	2	39	10	11	On
2pm	2	2	39	10	11	On
3pm	2	2	39	10	11	On
4pm	2	2	39	10	11	On
5pm	1	1	78	8	6.6	On
6pm	1	1	260	6	2.75	Off
7pm	1	1	260	6	2.75	Off
8pm	1	1	260	6	2.75	Off
9pm	0	0	0	1	1.1	Off
10pm	0	0	0	1	1.1	Off
11pm	0	0	0	1	1.1	Off

Table 16: Office / Staff Rooms

Lighting Energy Consumption Profile

Time	Artificial Lighting
0000-0600	10%
0600-0700	40%
0700-0800	80%
0800-1600	100%
1600-1700	80%
1700-2000	60%
2000-2400	10%

Table 17: Office / Staff Rooms lighting energy consumption profile

Libraries

Note: When calculating the HVAC energy consumption of these spaces, the model should use the specified lighting densities in the HVAC Model Operational Profile. When calculating the energy consumption of the lighting in the facility, the lighting profile should be used in conjunction with the lighting densities as per the lighting specifications.

<u>Input</u>

Upper Temperature Limit: 27°C
Lower Temperature Limit: 20°C
Air change rate: In accordance with AS1668.2 or engineered design

<u>HVAC Model Operational Profile</u>

Weekdays						
Time	Occupancy Gains (W/m²)		Occupancy (m²/person)	Lighting (W/m²)	Equipment (W/m²)	Plant Operation
	Sensible	Latent				
12am	0	0	0	0.6	0.25	Off
1am	0	0	0	0.6	0.25	Off
2am	0	0	0	0.6	0.25	Off
3am	0	0	0	0.6	0.25	Off
4am	0	0	0	0.6	0.25	Off
5am	0	0	0	0.6	0.25	Off
6am	0	0	0	0.6	0.25	Off
7am	2	2	47	3.6	4.25	On
8am	2	2	47	3.6	4.25	On
9am	10	9	7	12	5	On
10am	10	9	7	12	5	On
11am	10	9	7	12	5	On
12am	5	5	14	9.6	3.5	On
1pm	10	9	7	12	5	On
2pm	10	9	7	12	5	On
3pm	10	9	7	12	5	On
4pm	10	9	7	12	5	On
5pm	2	2	47	3.6	1.5	Off
6pm	2	2	47	3.6	1.5	Off
7pm	0	0	0	0.6	0.25	Off
8pm	0	0	0	0.6	0.25	Off
9pm	0	0	0	0.6	0.25	Off
10pm	0	0	0	0.6	0.25	Off
11pm	0	0	0	0.6	0.25	Off

Table 18: Office / Staff Rooms

<u>Lighting Energy Consumption Profile</u>

Time	Artificial Lighting
0000-0600	5%
0600-0700	30%
0700-0900	100%
0900-1200	80%
1200-1600	100%
1600-1800	30%
1800-2400	5%

Table 19: Libraries lighting energy consumption profile

Common Spaces

Note: When calculating the HVAC energy consumption of these spaces, the model should use the specified lighting densities in the HVAC Model Operational Profile. When calculating the energy consumption of the lighting in the facility, the lighting profile should be used in conjunction with the lighting densities as per the lighting specifications.

Input

Upper Temperature Limit: 27°C
Lower Temperature Limit: 20°C
Air change rate: In accordance with AS1668.2 or engineered design

HVAC Model Operational Profile

Weekdays						
Time	Occupancy Gains (W/m²)		Occupancy (m²/person)	Lighting (W/m²)	Equipment (W/m²)	Plant Operation
	Sensible	Latent				
12am	0	0	0	0.3	0	Off
1am	0	0	0	0.3	0	Off
2am	0	0	0	0.3	0	Off
3am	0	0	0	0.3	0	Off
4am	0	0	0	0.3	0	Off
5am	0	0	0	0.3	0	Off
6am	0	0	0	0.3	0	Off
7am	3	3	27	1.8	0	On
8am	3	3	27	1.8	0	On
9am	18	15	4	6	0	On
10am	18	15	4	6	0	On
11am	18	15	4	6	0	On
12am	9	8	8	4.8	0	On
1pm	18	15	4	6	0	On
2pm	18	15	4	6	0	On
3pm	18	15	4	6	0	On
4pm	18	15	4	6	0	On
5pm	3	3	27	1.8	0	Off
6pm	3	3	27	1.8	0	Off
7pm	0	0	0	0.3	0	Off
8pm	0	0	0	0.3	0	Off
9pm	0	0	0	0.3	0	Off
10pm	0	0	0	0.3	0	Off
11pm	0	0	0	0.3	0	Off

Table 20: Common Spaces

Lighting Energy Consumption Profile

Time	Artificial Lighting
0000-0600	5%
0600-0700	30%
0700-0900	100%
0900-1200	80%
1200-1600	100%
1600-1800	30%
1800-2400	5%

Table 21: Common spaces lighting energy consumption profile

Canteen

Note: When calculating the HVAC energy consumption of these spaces, the model should use the specified lighting densities in the HVAC Model Operational Profile. When calculating the energy consumption of the lighting in the facility, the lighting profile should be used in conjunction with the lighting densities as per the lighting specifications.

Input

Upper Temperature Limit: 27°C
Lower Temperature Limit: 20°C
Air change rate: In accordance with AS1668.2 or engineered design

HVAC Model Operational Profile

Weekdays						
Time	Occupancy Gains (W/m²)		Occupancy (m²/person)	Lighting (W/m²)	Equipment (W/m²)	Plant Operation
	Sensible	Latent				
12am	0	0	0	0	2.5	Off
1am	0	0	0	0	2.5	Off
2am	0	0	0	0	2.5	Off
3am	0	0	0	0	2.5	Off
4am	0	0	0	0	2.5	Off
5am	0	0	0	0	2.5	Off
6am	0	0	0	0	2.5	Off
7am	0	0	0	0	2.5	Off
8am	0	0	0	0	2.5	Off
9am	0	0	0	0	2.5	On
10am	2	1	66	20	17.5	On
11am	3	2	33	20	25	On
12am	3	2	33	20	25	On
1pm	3	2	33	20	25	On
2pm	3	2	33	20	25	On
3pm	0	0	0	0	0	On
4pm	0	0	0	0	0	Off
5pm	0	0	0	0	0	Off
6pm	0	0	0	0	0	Off
7pm	0	0	0	0	0	Off
8pm	0	0	0	0	0	Off
9pm	0	0	0	0	0	Off
10pm	0	0	0	0	0	Off
11pm	0	0	0	0	0	Off

Table 22: Canteens

Lighting Energy Consumption Profile

Time	Artificial Lighting
0000-1000	0%
1000-1500	100%
1500-2400	0%

Table 23: Canteen lighting energy consumption profile

Workshops

Note: When calculating the HVAC energy consumption of these spaces, the model should use the specified lighting densities in the HVAC Model Operational Profile. When calculating the energy consumption of the lighting in the facility, the lighting profile should be used in conjunction with the lighting densities as per the lighting specifications.

Input

Upper Temperature Limit: 27°C
Lower Temperature Limit: 20°C
Air change rate: In accordance with AS1668.2 or engineered design

HVAC Model Operational Profile

Weekdays						
Time	Occupancy Gains (W/m²)		Occupancy (m²/person)	Lighting (W/m²)	Equipment (W/m²)	Plant Operation
	Sensible	Latent				
12am	0	0	0	0.5	1.25	Off
1am	0	0	0	0.5	1.25	Off
2am	0	0	0	0.5	1.25	Off
3am	0	0	0	0.5	1.25	Off
4am	0	0	0	0.5	1.25	Off
5am	0	0	0	0.5	1.25	Off
6am	0	0	0	0.5	1.25	Off
7am	1	1	1.8	3	21.25	On
8am	1	1	1.8	3	21.25	On
9am	6	5	12	10	25	On
10am	6	5	12	10	25	On
11am	6	5	12	10	25	On
12am	3	3	6	8	17.5	On
1pm	6	5	12	10	25	On
2pm	6	5	12	10	25	On
3pm	6	5	12	10	25	On
4pm	6	5	12	10	25	On
5pm	1	1	1.8	3	7.5	Off
6pm	1	1	1.8	3	7.5	Off
7pm	0	0	0	0.5	1.25	Off
8pm	0	0	0	0.5	1.25	Off
9pm	0	0	0	0.5	1.25	Off
10pm	0	0	0	0.5	1.25	Off
11pm	0	0	0	0.5	1.25	Off

Table 24: Workshops

Lighting Energy Consumption Profile

Time	Artificial Lighting
0000-0600	5%
0600-0700	30%
0700-0900	100%
0900-1200	80%
1200-1600	100%
1600-1800	30%
1800-2400	5%

Table 25: Workshops lighting energy consumption profile

Gymnasiums

Note: When calculating the HVAC energy consumption of these spaces, the model should use the specified lighting densities in the HVAC Model Operational Profile. When calculating the energy consumption of the lighting in the facility, the lighting profile should be used in conjunction with the lighting densities as per the lighting specifications.

Input

Upper Temperature Limit: 27°C
Lower Temperature Limit: 20°C
Air change rate: In accordance with AS1668.2 or engineered design

HVAC Model Operational Profile

Weekdays						
Time	Occupancy Gains (W/m²)		Occupancy (m²/person)	Lighting (W/m²)	Equipment (W/m²)	Plant Operation
	Sensible	Latent				
12am	0	0	0	0.8	0	Off
1am	0	0	0	0.8	0	Off
2am	0	0	0	0.8	0	Off
3am	0	0	0	0.8	0	Off
4am	0	0	0	0.8	0	Off
5am	0	0	0	0.8	0	Off
6am	0	0	0	0.8	0	Off
7am	2	3	114	4.8	0	On
8am	2	3	114	4.8	0	On
9am	10	17	17	16	0	On
10am	10	17	17	16	0	On
11am	10	17	17	16	0	On
12am	5	9	34	12.8	0	On
1pm	10	17	17	16	0	On
2pm	10	17	17	16	0	On
3pm	10	17	17	16	0	On
4pm	10	17	17	16	0	On
5pm	2	3	114	4.8	0	Off
6pm	2	3	114	4.8	0	Off
7pm	0	0	0	0.8	0	Off
8pm	0	0	0	0.8	0	Off
9pm	0	0	0	0.8	0	Off
10pm	0	0	0	0.8	0	Off
11pm	0	0	0	0.8	0	Off

Table 26: Gymnasiums

Lighting Energy Consumption Profile

Time	Artificial Lighting
0000-0600	5%
0600-0700	30%
0700-0900	100%
0900-1200	80%
1200-1600	100%
1600-1800	30%
1800-2400	5%

Table 27: Gymnasium lighting energy consumption profile

Car Parks

Note 1: When calculating the HVAC energy consumption of these spaces, the model should use the specified lighting densities in the HVAC Model Operational Profile. When calculating the energy consumption of the lighting in the facility, the lighting profile should be used in conjunction with the lighting densities as per the lighting specifications.

Note 2: Only small car parks (those with less than 1 car parking space per 200m² NLA) are assessed by the energy tool. For this reason, the car park benchmark is calculated as being 30% "entry area" and lighting benchmark for car parks is assuming that 30% of car park area is located within 20m of an entry.

Input

Upper Temperature Limit: None
Lower Temperature Limit: None
Air change rate: In accordance with AS1668.2 or engineered design

HVAC Model Operational Profile

Weekdays			
Time	Lighting (W/m²)	Equipment (W/m²)	Mechanical Exhaust
12am	0	0	Off
1am	0	0	Off
2am	0	0	Off
3am	0	0	Off
4am	0	0	Off
5am	0	0	Off
6am	0	0	Off
7am	10	0	On
8am	10	0	On
9am	10	0	On
10am	10	0	On
11am	10	0	On
12am	10	0	On
1pm	10	0	On
2pm	10	0	On
3pm	10	0	On
4pm	10	0	On
5pm	10	0	On
6pm	10	0	On
7pm	0	0	Off
8pm	0	0	Off
9pm	0	0	Off
10pm	0	0	Off
11pm	0	0	Off

Table 28: Car Parks

Lighting Energy Consumption Profile

Time	Artificial Lighting
0000-0600	0%
0700-1800	100%
1800-2400	0%

Table 29: Car park lighting energy consumption profile

APPENDIX D: UNIVERSITY BUILDINGS OPERATIONAL PROFILES

Teaching / Classroom Spaces

Note: When calculating the HVAC energy consumption of these spaces, the model should use the specified lighting densities in the HVAC Model Operational Profile. When calculating the energy consumption of the lighting in the facility, the lighting profile should be used in conjunction with the lighting densities as per the lighting specifications.

Input

Upper Temperature Limit: 24°C
Lower Temperature Limit: 20°C
Air change rate: In accordance with AS1668.2 or engineered design

HVAC Model Operational Profile

Weekdays						
Time	Occupancy Gains (W/m²)		Occupancy (m²/person)	Lighting (W/m²)	Equipment (W/m²)	Plant Operation
	Sensible	Latent				
12am	0	0	0	0.5	0	Off
1am	0	0	0	0.5	0	Off
2am	0	0	0	0.5	0	Off
3am	0	0	0	0.5	0	Off
4am	0	0	0	0.5	0	Off
5am	0	0	0	0.5	0	Off
6am	0	0	0	0.5	0	Off
7am	3	3	24	5	0	On
8am	3	3	24	5	0	On
9am	6	5	12	10	0	On
10am	6	5	12	10	0	On
11am	6	5	12	10	0	On
12am	3	3	24	8	0	On
1pm	6	5	12	10	0	On
2pm	6	5	12	10	0	On
3pm	6	5	12	10	0	On
4pm	6	5	12	10	0	On
5pm	2	1	60	2	0	Off
6pm	2	1	60	2	0	Off
7pm	2	1	60	2	0	Off
8pm	1	1	240	0.5	0	Off
9pm	1	1	240	0.5	0	Off
10pm	1	1	240	0.5	0	Off
11pm	1	1	240	0.5	0	Off

Table 30: Teaching / Classroom Spaces

Lighting Energy Consumption Profile

Time	Artificial Lighting
0000-0700	5%
0700-0900	50%
0900-1200	100%
1200-1300	80%
1300-1700	100%

1700-2000	20%
2000-2400	5%

Table 31: Teaching / Classroom Spaces lighting energy consumption profile

Dry Labs / Specialty Learning Spaces

Note: When calculating the HVAC energy consumption of these spaces, the model should use the specified lighting densities in the HVAC Model Operational Profile. When calculating the energy consumption of the lighting in the facility, the lighting profile should be used in conjunction with the lighting densities as per the lighting specifications.

Input

Upper Temperature Limit: 24°C
Lower Temperature Limit: 20°C
Air change rate: In accordance with AS1668.2 or engineered design

HVAC Model Operational Profile

Weekdays						
Time	Occupancy Gains (W/m²)		Occupancy (m²/person)	Lighting (W/m²)	Equipment (W/m²)	Plant Operation
	Sensible	Latent				
12am	0	0	0	0.5	1.35	Off
1am	0	0	0	0.5	1.35	Off
2am	0	0	0	0.5	1.35	Off
3am	0	0	0	0.5	1.35	Off
4am	0	0	0	0.5	1.35	Off
5am	0	0	0	0.5	1.35	Off
6am	0	0	0	0.5	1.35	Off
7am	3	3	24	5	13.5	On
8am	3	3	24	5	13.5	On
9am	6	5	12	10	27	On
10am	6	5	12	10	27	On
11am	6	5	12	10	27	On
12am	3	3	24	8	18.9	On
1pm	6	5	12	10	27	On
2pm	6	5	12	10	27	On
3pm	6	5	12	10	27	On
4pm	6	5	12	10	27	On
5pm	2	1	60	2	5.4	Off
6pm	2	1	60	2	5.4	Off
7pm	2	1	60	2	5.4	Off
8pm	1	1	240	0.5	1.35	Off
9pm	1	1	240	0.5	1.35	Off
10pm	1	1	240	0.5	1.35	Off
11pm	1	1	240	0.5	1.35	Off

Table 32: Dry Lab / Specialty Learning Spaces

Lighting Energy Consumption Profile

Time	Artificial Lighting
0000-0700	5%
0700-0900	50%
0900-1200	100%
1200-1300	80%
1300-1700	100%

1700-2000	20%
2000-2400	5%

Table 33: Dry Lab / Specialty Learning Spaces lighting energy consumption profile

Office / Administrative Spaces

Note: When calculating the HVAC energy consumption of these spaces, the model should use the specified lighting densities in the HVAC Model Operational Profile. When calculating the energy consumption of the lighting in the facility, the lighting profile should be used in conjunction with the lighting densities as per the lighting specifications.

<u>Input</u>

Upper Temperature Limit: 24°C
Lower Temperature Limit: 20°C
Air change rate: In accordance with AS1668.2 or engineered design

<u>HVAC Model Operational Profile</u>

Weekdays						
Time	Occupancy Gains (W/m²)		Occupancy (m²/person)	Lighting (W/m²)	Equipment (W/m²)	Plant Operation
	Sensible	Latent				
12am	0	0	0	1	1.1	Off
1am	0	0	0	1	1.1	Off
2am	0	0	0	1	1.1	Off
3am	0	0	0	1	1.1	Off
4am	0	0	0	1	1.1	Off
5am	0	0	0	1	1.1	Off
6am	0	0	0	1	1.1	Off
7am	1	1	178	4	2.75	On
8am	2	2	45	8	7.7	On
9am	3	3	27	10	11	On
10am	3	3	27	10	11	On
11am	3	3	27	10	11	On
12am	3	3	27	10	11	On
1pm	3	3	27	10	11	On
2pm	3	3	27	10	11	On
3pm	3	3	27	10	11	On
4pm	3	3	27	10	11	On
5pm	2	2	54	8	6.6	On
6pm	1	1	178	6	2.75	Off
7pm	1	1	178	6	2.75	Off
8pm	1	1	178	6	2.75	Off
9pm	0	0	0	1	1.1	Off
10pm	0	0	0	1	1.1	Off
11pm	0	0	0	1	1.1	Off

Table 34: Office / Administrative Spaces

<u>Lighting Energy Consumption Profile</u>

Time	Artificial Lighting
0000-0700	5%
0700-0900	50%
0900-1200	100%
1200-1300	80%
1300-1700	100%

1700-2000	20%
2000-2400	5%

Table 35: Office / Administrative Spaces lighting energy consumption profile

Common Spaces

Note: When calculating the HVAC energy consumption of these spaces, the model should use the specified lighting densities in the HVAC Model Operational Profile. When calculating the energy consumption of the lighting in the facility, the lighting profile should be used in conjunction with the lighting densities as per the lighting specifications.

Input

Upper Temperature Limit: 24°C
Lower Temperature Limit: 20°C
Air change rate: In accordance with AS1668.2 or engineered design

HVAC Model Operational Profile

Weekdays						
Time	Occupancy Gains (W/m²)		Occupancy (m²/person)	Lighting (W/m²)	Equipment (W/m²)	Plant Operation
	Sensible	Latent				
12am	0	0	0	0.3	0	Off
1am	0	0	0	0.3	0	Off
2am	0	0	0	0.3	0	Off
3am	0	0	0	0.3	0	Off
4am	0	0	0	0.3	0	Off
5am	0	0	0	0.3	0	Off
6am	0	0	0	0.3	0	Off
7am	1	1	54	1.8	0	On
8am	1	1	54	1.8	0	On
9am	3	3	27	6	0	On
10am	3	3	27	6	0	On
11am	3	3	27	6	0	On
12am	2	2	54	4.8	0	On
1pm	3	3	27	6	0	On
2pm	3	3	27	6	0	On
3pm	3	3	27	6	0	On
4pm	3	3	27	6	0	On
5pm	1	1	134	1.8	0	Off
6pm	1	1	134	1.8	0	Off
7pm	0	0	134	0.3	0	Off
8pm	0	0	534	0.3	0	Off
9pm	0	0	534	0.3	0	Off
10pm	0	0	534	0.3	0	Off
11pm	0	0	534	0.3	0	Off

Table 36: Common Spaces

Lighting Energy Consumption Profile

Time	Artificial Lighting
0000-0700	5%
0700-0900	50%
0900-	100%

1200	
1200-1300	80%
1300-1700	100%
1700-2000	20%
2000-2400	5%

Table 37: Common Spaces lighting energy consumption profile

Wet Labs

Note: When calculating the HVAC energy consumption of these spaces, the model should use the specified lighting densities in the HVAC Model Operational Profile. When calculating the energy consumption of the lighting in the facility, the lighting profile should be used in conjunction with the lighting densities as per the lighting specifications.

Input

Upper Temperature Limit: 24°C
Lower Temperature Limit: 20°C
Air change rate: In accordance with AS1668.2 or engineered design

HVAC Model Operational Profile

Weekdays						
Time	Occupancy Gains (W/m²)		Occupancy (m²/person)	Lighting (W/m²)	Equipment (W/m²)	Plant Operation
	Sensible	Latent				
12am	1	1	178	2.25	6	Off
1am	1	1	178	2.25	6	Off
2am	1	1	178	2.25	6	Off
3am	1	1	178	2.25	6	Off
4am	1	1	178	2.25	6	Off
5am	1	1	178	2.25	6	Off
6am	1	1	178	2.25	6	Off
7am	1	1	178	2.25	6	On
8am	3	3	27	15	40	On
9am	3	3	27	15	40	On
10am	3	3	27	15	40	On
11am	3	3	27	15	40	On
12am	2	2	54	12	28	On
1pm	3	3	27	15	40	On
2pm	3	3	27	15	40	On
3pm	3	3	27	15	40	On
4pm	3	3	27	15	40	On
5pm	3	3	27	15	40	On
6pm	1	1	77	3	8	On
7pm	1	1	77	3	8	On
8pm	1	1	77	3	8	On
9pm	1	1	77	3	8	On
10pm	1	1	178	2.25	2	On
11pm	1	1	178	2.25	2	On

Table 38: Wet Labs

Lighting Energy Consumption Profile

Time	Artificial

	Lighting
0000-0800	15%
0800-0900	85%
0900-1200	100%
1200-1300	80%
1300-1800	100%
1800-2200	35%
2000-2400	5%

Table 39: Wet Labs lighting energy consumption profile

Gymnasium

Note: When calculating the HVAC energy consumption of these spaces, the model should use the specified lighting densities in the HVAC Model Operational Profile. When calculating the energy consumption of the lighting in the facility, the lighting profile should be used in conjunction with the lighting densities as per the lighting specifications.

<u>Input</u>

Upper Temperature Limit: 24°C
Lower Temperature Limit: 20°C
Air change rate: In accordance with AS1668.2 or engineered design

<u>HVAC Model Operational Profile</u>

Weekdays						
Time	Occupancy Gains (W/m²)		Occupancy (m²/person)	Lighting (W/m²)	Equipment (W/m²)	Plant Operation
	Sensible	Latent				
12am	0	0	0	0.8	0.75	Off
1am	0	0	0	0.8	0.75	Off
2am	0	0	0	0.8	0.75	Off
3am	0	0	0	0.8	0.75	Off
4am	0	0	0	0.8	0.75	Off
5am	0	0	0	0.8	0.75	Off
6am	13	23	13	16	12	On
7am	13	23	13	16	12	On
8am	13	23	13	16	12	On
9am	4	7	40	16	3.75	On
10am	4	7	40	16	3.75	On
11am	4	7	40	16	3.75	On
12am	16	28	10	16	15	On
1pm	16	28	10	16	15	On
2pm	4	7	40	16	3.75	On
3pm	4	7	40	16	3.75	On
4pm	4	7	40	16	3.75	On
5pm	13	23	13	16	12	On
6pm	13	23	13	16	12	On
7pm	13	23	13	16	12	On
8pm	6	10	29	16	5.25	On
9pm	6	10	29	16	5.25	On
10pm	0	0	0	0.8	0.75	Off

11pm	0	0	0	0.8	0.75	Off

Table 40: Wet Labs

Lighting Energy Consumption Profile

Time	Artificial Lighting
0000-0600	5%
0600-2200	100%
2200-2400	5%

Table 41: Wet Labs lighting energy consumption profile

Car Parks

Note 1: When calculating the HVAC energy consumption of these spaces, the model should use the specified lighting densities in the HVAC Model Operational Profile. When calculating the energy consumption of the lighting in the facility, the lighting profile should be used in conjunction with the lighting densities as per the lighting specifications.

Note 2: Only small car parks (those with less than 1 car parking space per 200m² NLA) are assessed by the energy tool. For this reason, the car park benchmark is calculated as being 30% "entry area" and lighting benchmark for car parks is assuming that 30% of car park area is located within 20m of an entry.

Input

Upper Temperature Limit: None
Lower Temperature Limit: None
Air change rate: In accordance with AS1668.2 or engineered design

HVAC Model Operational Profile

Weekdays			
Time	**Lighting (W/m^2)**	**Equipment (W/m^2)**	**Mechanical Exhaust**
12am	0	0	Off
1am	0	0	Off
2am	0	0	Off
3am	0	0	Off
4am	0	0	Off
5am	0	0	Off
6am	0	0	Off
7am	10	0	On
8am	10	0	On
9am	10	0	On
10am	10	0	On
11am	10	0	On
12am	10	0	On
1pm	10	0	On
2pm	10	0	On
3pm	10	0	On
4pm	10	0	On
5pm	10	0	On
6pm	10	0	On
7pm	0	0	Off
8pm	0	0	Off
9pm	0	0	Off
10pm	0	0	Off
11pm	0	0	Off

Table 42: Car Parks

Lighting Energy Consumption Profile

Time	Artificial Lighting
0000-0600	0%
0700-1800	100%
1800-2400	0%

Table 43: Car park lighting energy consumption profile

APPENDIX E: ANCILLARY ENERGY CONSUMPTION

Domestic hot water energy consumption

The following table shows the hot water consumption that is to be assumed for each space type when calculating the energy consumption of a hot water system. Note that it is assumed that there is not hot water energy consumption associated with car parks.

		Occupancy (m^2/person/day)	Hot Water Consumption (L/person/day)	Domestic hot water supply (L/m^2/day)
	Data Source	AS1668.2	TRA-3 compliance with 3 star showers	Calculated
Primary / High Schools	Classroom / Multipurpose Spaces	12	1.5	0.13
	Computer and Physics Labs	4	1.5	0.38
	Office and Staff Rooms	39	5.5	0.15
	Library	7	1.5	0.22
	Common Spaces	4	1.5	0.38
	Canteen	33	1.5	0.05
	Workshops	12	1.5	0.13
	Gymnasiums	17	12	0.71
	Car Parks	0	0	0
University Buildings	Teaching / Classroom Spaces	9	1.5	0.17
	Dry Labs / Specialty Learning Spaces	9	1.5	0.17
	Office / Administrative Spaces	20	5.5	0.28
	Common Spaces	20	1.5	0.08
	Wet Labs	20	1.5	0.08
	Gymnasiums	19	12	0.64
	Car Parks	0	0	0

Table 44: Benchmarks for hot water energy consumption

*The hot water supply is a fixed component. It may only be reduced if documentation is provided proving that hot water consumption is less than average.

Protocol for calculating energy use

1. Calculate the **Daily Domestic Hot Water Requirements** multiplying the hot water supply (L/m^2/day) found in the table above by each of the space type areas (m^2).
2. Calculate the **Daily Domestic Hot Water Energy Requirements** by determining how much primary energy input is required to heat this amount of water to 60°C per day **using the domestic hot water systems as designed for the education facility.** Ensure distribution and generation efficiencies are included. Where distribution efficiencies are unknown, an efficiency of

40% should be applied to any pump in the system, and piping losses of 20W / linear m of pipe should be applied.

3. Multiply the Daily Domestic Hot Water Energy Requirement by 260 days to calculate the Yearly Hot Water Energy Requirement. This is the figure to be entered into the **Green Star Education As Built Energy Credit Calculator**.

Example (yellow section to be filled in)

WATER SUPPLIED TO:	HOT WATER REQUIREMENTS (L/m²/day)	TOTAL AREA (m²)	HOT WATER REQUIREMENTS (L/day)	DAILY ENERGY REQUIRED TO HEAT HOT WATER (kWh/day)	YEARLY ENERGY REQUIRED TO HEAT HOT WATER (kWh/year)
Classroom / Multipurpose Spaces	0.13	2500	325	18	4653

Table 45: Example to how to calculate hot water energy consumption

The figure to be entered into the Energy Calculator is 6760.

Protocol for calculating lift energy use

1. Determine the lift power ratings (both freight and customer lifts) from supplier specifications.
2. The **Usage Factor** is 0.75 and takes into account stopping and starting of the lift.
3. Calculate the **Yearly Energy Usage**. This can be done by multiplying the lift power rating by the number of lifts, then by the usage factor and finally by 8 hours a day, 260 days a year (2080 hours/year). This is the figure to be entered into the **Education As Built Energy Credit Calculator**.

Example (yellow sections are those that are to be filled in)

LIFT POWER RATING (kW)	NUMBER OF LIFTS	USAGE FACTOR	HOURS IN A YEAR	YEARLY ENERGY USAGE (kWh/year)
30kW (passenger lift)	1	0.75	2080	46800
TOTAL YEARLY ENERGY CONSUMPTION (kWh/year)				46800

Table 46: Example of how to calculate lift energy consumption

Protocol for calculating escalator and travelator energy use

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

2. Determine the **Usage Factor** based on the presence of an escalator or travelator sensor. These sensors detect movement and start the escalator or travelator moving if someone is walking towards it. The usage factor is:
    a. 0.75 if there is sensor; and
    b. 1 with a no sensor.

3. Calculate the **Yearly Energy Usage**. This can be done by multiplying the power rating by the number of escalators or travelators, then by the usage factor and finally by 8 hours a day, 260 days a year (2080 hours/year). This is the figure to be entered into the **Education As Built Energy Credit Calculator**.

Example (yellow sections are those that are to be filled in)

ESCALATOR TRAVELATOR POWER RATING	NUMBER OF ESCALATORS	USAGE FACTOR (sensor dependent)	HOURS IN A YEAR	YEARLY ENERGY USAGE (kWh/year)
8kW (without sensor)	4	1	2080	66560
8kW (with sensor)	2	0.75	2080	24960
TOTAL YEARLY ENERGY CONSUMPTION (kWh/year)				91520

Table 47: Example of how to calculate escalator or travelator energy consumption