Green Star SA – Office v1

ENERGY CALCULATOR & MODELLING PROTOCOL GUIDE – VERSION 1.1

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1 Executive Summary

The Green Star SA – Office v1 rating tool has been developed to evaluate the predicted performance of office facilities based on a variety of environmental criteria. The Energy Calculator within this tool compares the predicted energy consumption of an office facility to a benchmark based on a notional building complying with SANS 204:2008 of the same size as the actual building and in the same location. The carbon emissions associated with the energy consumption are determined by the calculator, and points are awarded to any facility which improves on the benchmark.

To use the calculator, the predicted energy consumption of both the actual facility and the notional building 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 office facilities.

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

Finally, this guide includes information on how to enter the simulation outputs and the ancillary load calculations into the Green Star SA – Office v1 rating tool Energy Calculator. The calculator converts the energy use into carbon emissions and indicates the percentage improvement of the actual building compared to the notional building. Points are awarded based on 0 points for no improvement, up to a maximum of 20 points for a building with net zero operating emissions.

2 Acknowledgements

Much of the methodology and modelling protocol details are based on those of the Australian Green Star – Office v3 rating tool, and parts of this guidance note are based on the associated Energy Calculator Guide by consultant Advanced Environmental. The Green Building Council of South Africa acknowledges the work of technical consultant Arup in adapting these items to the South African Green Star SA – Office v1 tool, as well as the significant volunteer help of PJ Carew Consulting and WSP Group in later revisions.

3 Introduction

The Green Building Council of South Africa (GBCSA) is developing a suite of rating tools to assess the environmental performance of buildings in South Africa. As part of this package, the Green Star SA – Office v1 rating tool assesses the environmental performance of office facilities by measuring their environmental impact. Part of this assessment includes determining the predicted energy consumption of the office facility.

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. Thermal modelling must be done using software that complies with the requirements in this guide. Systems modelling may be done in a spreadsheet program or by hand, provided full details are submitted.

This report has been written as a guide to these calculations and to how the data must be entered into the Energy Calculator to produce a score.

Please note that the GBCSA does not keep a list of currently acceptable software packages and does not endorse any particular package or company. Any software program meeting the requirements in this guide is acceptable.

4 General Methodology

4.1 Model Notional SANS204 Building

A building in the same location and with the same geometry as the actual building is modelled, with defined areas of glazing and fixed fabric performance and M&E systems performance. The building is generally as defined by the SANS 204-3:2008 *(Energy efficiency in buildings Part 3: The application of the energy efficiency requirements for buildings with artificial environmental control)* deemed to comply clauses. The building is modelled in four orientations (at actual orientation, orientation + 90°, orientation +180°, orientation +270°), and an average taken. This approach is to allow benefit to be taken for optimum orientation of the actual building.

4.2 Model Actual Building

The actual building is modelled, using exactly the same simulation software, weather data and tenant assumptions as the model of the notional building, but with the actual building fabric and HVAC systems.

4.3 Enter energy use into Green Star SA – Office v1 energy calculator

The HVAC energy uses predicted by the models above for the notional building and the actual building are entered into the calculator. The other remaining energy uses (e.g. lifts, hot water, car park ventilation, external lighting etc) are calculated using this protocol. Once the total is obtained, any renewable energy sources and on site generation are taken into account. The calculator produces an estimate of the carbon emissions/m²/year for both the notional building and the actual building.

The final Ene-1 point score is awarded based on the percentage improvement of the actual building compared to the notional building in terms of "base building" carbon emissions, on a linear scale with 0 points representing no improvement and 20 points representing a building with net zero operating emissions.

The "base building" carbon emissions include energy used for heating, cooling, ventilation, lifts, non tenant (common area) lighting, external lighting etc, but do not include tenant equipment and tenant lighting energy use. Efficient tenant lighting is rewarded by other credits within the Green Star SA – Office energy section. However, efficient lighting and automatic daylight control can be included insofar as they reduce the cooling load of the building.

5 Guidelines for Modelling Parameters

The parameters for simulation of HVAC energy consumption of an office facility are given in this section. These are standard criteria that must be adhered to in ordered to comply with the Green Star SA – Office v1 energy credit requirements. The outputs from this simulation will then be entered in the calculator, as outlined in the following section.

Whenever assumptions are used, they must be justified and must be conservative assumptions.

5.1 General Modelling Parameters

The following requirements refer to both the modelling of the notional building and the actual building. The same simulation package and weather data must be used for both models.

Modelling Parameter	*Requirements*	*Documentation*
Simulation Package	• Passed the BESTEST[1] validation test; or • The European Union draft standard EN13791 July 2000; or • Be tested in accordance with ANSI/ASHRAE Standard 140-2001. Please contact the Green Building Council of South Africa if none of the above options can be complied with.	Energy Report: • Simulation brief for assessor (see Appendix A).
Weather Data	• A Test Reference Year (TRY) if the building location is within 50km of a TRY location; or • In the absence of local TRY weather data, an actual year of recorded weather data from a location within 50km of the building location; or • In the absence of TRY or actual weather data within 50km, interpolated data based upon 3 points within 250km of the building location. Weather data can be obtained using the Meteonorm software.	Energy Report: • Type of data (TRY / year / interpolated). • Weather station location.

[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".

Overshadowing	• Demonstrate that overshadowing from the surrounding environment has been taken into account in the model or explain why it does not need to be considered in both the notional and actual building models.	Verification Documents: • Design or as-installed (where appropriate) relevant architectural drawings. Energy Report: • Details of how overshadowing from the external environment has been represented in the model.
Space Type Breakdown	• Demonstration that the correct space types have been allocated in the building, and that the correct areas have been used.	Verification Documents: • Design or as-installed (where appropriate) colour coded floor plans showing the location of each different space type as used in the calculator. Energy Report: • Details of how each relevant space type was chosen for each section of the building.

Table 1: General Parameters Table

5.2 Building Envelope

	Notional SANS204 Building	Actual Building
Geometry	Geometry based on actual geometry of building	Geometry based on actual geometry of building
Fabric	Fabric based on SANS204-3 as follows: • Windows U value 5.6 and SHGF 0.77 (clear single glazing, timber framed). Windows to be distributed on all sides of the building such as to achieve compliance with the SANS204-3 formula • Rooflights at 10% of floor area, with U value 2.5 and SHGF 0.35 • Walls insulated to R = 2.2 • Roof insulated to R = 2.7 to 3.7 depending on climatic zone	Fabric as actual fabric
Orientation	Model in four orientations (actual, actual+90°, actual+180° and actual+270°) and take average	Use actual orientation

Table 2: Building envelope parameters - Specific

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: • Design or as-installed (where appropriate) 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, demonstrating a conservative approach.
Insulation	• Demonstrate that insulation in the walls, ceiling and floors has been accurately represented.	Verification Documents: • Design or as-installed (where appropriate) relevant architectural drawings. • Design or as-installed (where appropriate) 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: • Design or as-installed (where appropriate) 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: • Design or as-installed (where appropriate) relevant architectural drawings. Energy Report: • Details of the window and spandrel sizes that have been used in the model.

Shading	• Demonstrate that all shading of windows and external building fabric are accurately represented.	Verification Documents: • Design or as-installed (where appropriate) 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: • Design or as-installed (where appropriate) 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: • Design or as-installed (where appropriate) relevant architectural drawings. • Design or as-installed (where appropriate) relevant pages from the façade specification that show infiltration or façade sealing characteristics. Energy Report: • Details of how infiltration has been modelled.

Table 3: Building envelope parameters - general

5.3 Internal Design Criteria

	Notional SANS204 Building	Actual Building
Internal design temperatures	24°C in summer 20°C in winter	as client brief or if no client brief than as notional building
Occupancy	15 m²/person	15 m²/person (even if client brief is higher/lower)
Lighting (in office areas)	12 W/m²	12 W/m² or as actual design if fitout included in works
Equipment (in office areas)	11 W/m²	11 W/m²
Fresh Air rate	Actual design rate or 8 litres/sec/person (whichever is lower)	Actual design rate

Table 4: Internal Design Criteria - Specific

Hourly profiles of these loads must be as per the schedules given in Appendix C of this protocol

Modelling Parameter	*Requirements*	*Documentation*
Lighting	• Demonstrate that lighting is calculated based on floor area. • Demonstrate that the appropriate HVAC Model Operational Profile (see Appendix C) has been used in the HVAC Model	Verification Documents: • Area schedule. • Design or as-installed (where appropriate) Reflected ceiling plans showing each typical lighting layout. • Lighting calculations demonstrating lighting power density. 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 are calculated based on floor area. • Demonstrate that the equipment loads are modelled using the operational profiles as prescribed in Appendix C.	Verification Documents: • Area schedule. Energy Report: • Details of space type areas using the definitions in Appendix B. • Details of how the equipment load densities have been calculated. • Details of how the operational profiles have been modelled.
Occupancy	• Demonstrate that all occupancies are calculated based on floor area. • Demonstrate that the occupancy profile used is that prescribed for each space type in Appendix C.	Verification Documents: • Area schedule. Energy Report: • Details of space type areas using the definitions in Appendix B • Details on how the occupancy loads have been modelled • Details on the profiles used for occupancy

Table 5: Internal Design Criteria - general

5.4 HVAC Systems Simulation

The HVAC system energy simulation for the notional building should include for
1) primary cooling generation and heat rejection,
2) water side cooling distribution energy,
3) air side air distribution energy and air side heating
4) ventilation air
5) distribution losses shall not be accounted for (heat loss from ducting and piping)
6) leakage shall not be accounted for (air loss from ducting during distribution)

System zoning for the notional building should be as per the actual building.

	Notional SANS204 Building	Actual Building
Primary cooling and heat rejection – heat rejection, compressor, evaporator	The whole building cooling load shall be served by an air cooled chiller with performance interpolated based on table 7 (Interpretation based on ASHRAE 90.1 – 2007 TABLE 6.8.1.C, minimum efficiency 2.80 COP, 3.05 Integrated Part Load Value (IPLV))	As actual design
Heating	Heating is to be provided by terminal electric reheat controlled as per SANS 204 4.8.7.3.3(a) – note zoning is to be as per the actual design	As actual design
Chilled water system	Cooling will be distributed through a constant volume chilled water distribution system. Chilled water volume pumped shall be calculated based on a temperature difference of 6 ºC. Pump power shall be 349kW/1000L/s (Interpretation based on ASHRAE 90.1 – 2007 G3.1.3.10)	As actual design
Supply air fans (Air Handling Units)	Supply air fan power shall be based on a variable air volume supply. The supply air temperature shall be 12ºC. The minimum supply air volume shall be the minimum fresh air ventilation rate. Heating fan power shall be calculated based on a variable air volume supply air temperature of 30 deg C. Specific fan power to be 2.1W/l/s (per SANS 204-3:2008). The specific fan power is the sum of the design total circuit-watts, including all loses through switchgear and controls such as inverters, of all fans that supply air and exhaust it back outside the building (i.e., the sum of supply and extract fans), divided by the design ventilation rate through the building.	As actual design

Fresh air ventilation fans	Fresh air shall be delivered by constant volume fan systems. The fresh air volume delivered shall be as defined in the internal design criteria. Supply air fan power is to be calculated on the basis of 1.6W/l/s (per SANS 204-3:2008)	As actual design
Distribution losses	No ducting or piping heat loss should be accounted for in the notional building.	As actual design
Leakage	No duct leakage shall be accounted for in the notional building.	As actual design
HVAC system controls	to satisfy SANS204-3	As actual design

Table 6: HVAC system parameters – Specific

	Load as % of Design Load									
Outside Air Temperature	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
35°C	2.80	2.80	2.87	2.92	2.93	2.97	3.08	3.18	3.16	3.14
20°C	2.80	2.92	3.02	3.07	3.09	3.13	3.24	3.35	3.32	3.30

Table 7: Cooling plant performance

Cooling plant Coefficient of Performance (COP) at varying load and outdoor air temperatures (based on COP ≥ 2.80 and IPLV (Integrated Part Load Value) ≥ 3.05 as per ASHRAE 90.1 – 2007 TABLE 6.8.1.C - the above values give an IPLV value of 3.15 which is marginally better than the minimum required).

If a common central plant is shared by the development pursuing certification 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 pursuing certification;

2) The part load curves for the actual central plant shall be applied proportionally to the central plant used for the energy calculations.

Note that any apportioning of the central plant should be confirmed with the GBCSA through a Credit Interpretation Request.

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

Boiler plant	• Demonstrate that the boiler plant size, thermal efficiency and distribution efficiency are accurately reflected in the model.	Verification Documents: • Design or as-installed (where appropriate) 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: • Design or as-installed (where appropriate) 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.
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.	Verification Documents: • Design or as-installed (where appropriate) relevant pages from the hydraulic and mechanical specifications showing chilled water pump data – static pressure and flow rate in L/s. Energy Report: • Calculation of chilled water pumping.

Heating hot water	• Demonstrate that the hot water pumping is calculated using the building heating load, the static pressure of the hot water pumps (typically 250kPa) and the flow rate in L/s.	Verification Documents: • Design or as-installed (where appropriate) relevant pages from the hydraulic and mechanical specifications showing hot water pump data – static pressure and flow rate in L/s. Energy Report: • Calculation of hot water pumping.
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.	Verification Documents: • Design or as-installed (where appropriate) 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. Energy Report: • If relevant, details on how the tenant condenser water loop pumping was calculated.
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: • Design or as-installed (where appropriate) 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
Controls - Economy Cycle	• Demonstrate that economy cycles have been modelled to reflect system specification noting any enthalpy/temperature cut-off and control point.	Verification Documents: • Design or as-installed (where appropriate) 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
Controls - 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	Verification Documents: • Design or as-installed (where appropriate) relevant pages from mechanical specification giving details of the design temperature and HVAC cooling and heating setpoints

	• 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.	Energy Report: • Detail of how design temperatures and setpoints have been modelled
Controls - Airflow	• 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: • Design or as-installed (where appropriate) 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
Controls - Minimum turndown	• Demonstrate, where relevant, that the minimum turndown airflow of each air supply is accurately reflected in the model.	Verification Documents: • Design or as-installed (where appropriate) 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: • Design or as-installed (where appropriate) 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: • Design or as-installed (where appropriate) 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 8: HVAC system simulation – general

6 Guidelines for Other Parameters

6.1 Extract & Miscellaneous Fans

Any fans not included in the building simulation (see above), must be accounted for in the "miscellaneous fans" section of the calculator. This includes toilet and kitchenette extract fans, car park ventilation fans, ceiling mounted propeller type fans (if provided by landlord) etc.

	Notional SANS204 Building	Actual Building
Car Park Ventilation	Assume no energy use for car parking on first basement (B1) levels and above (ie assume natural ventilation). For car parking on lower basements, use the same flow rates as the actual peak design, with a specific fan power of 1.6 W/l/s (per SANS 204-3:2008) assumed to be constant volume.	As actual design
Exhaust Ventilation	Flow rates as actual design, with specific fan power of 1.6 W/l/s (per SANS 204-3:2008) assumed to be constant volume	As actual design

Table 9: Mechanical Exhaust parameters - specific

Modelling Parameter	*Requirements*	*Documentation*
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: • Design or as-installed (where appropriate) 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 10: Mechanical Exhaust parameters - general

6.2 Lighting

Lighting in tenant areas

Tenant area lighting usage should be calculated either manually or using the computer simulation and entered into the calculator. However, this usage is for information only, and is not included in the base building energy use comparison. Green Star SA rewards efficient tenant lighting in separate credits Ene-3 and Ene-4. Generally a lighting load of 12 W/m² should be assumed (refer design criteria section). Where installed as part of the landlord works, lighting controls and daylight sensing can be incorporated in the simulation and will be reflected in the number of points awarded insofar as they reduce the cooling loads of the building. For daylight dimming refer Appendix F.

Lighting in non tenant areas, in external areas and in car parks.

The energy use associated with all lighting in non tenant areas should be calculated and entered into the calculator. The energy estimate should be based on the actual numbers of fittings used and the ratings of each fitting, together with the consumption profiles given in Appendix C. Where installed as part of the landlord works, lighting controls and daylight sensing can be incorporated in the calculation. For daylight dimming refer Appendix F.

Modelling Parameter	*Requirements*	*Documentation*
Lighting (non-tenant areas)	• Demonstrate that lighting is calculated based on actual fittings. • 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: • <u>Controls</u> – where credit Ene-4 is achieved, the Lighting (with controls) profile may be used. • <u>Time Clocks/Photocell:</u> If external lighting operates on a time clock or photocell, then the External Lighting (timeclock/ photocell) profile must be used. • <u>Presence/Absence sensors</u>: Where presence detectors are provided at least every 45m² of floor area, the profile Lighting (with controls and occupancy sensors) may be used. • <u>Daylight dimming:</u> Details on this system, and the calculation method must be provided. The calculation must use the methodology outlined in Appendix F.	<u>Verification Documents:</u> • Area schedule • Design or as-installed (where appropriate) reflected ceiling plans with base building lighting design • Design or as-installed (where appropriate) relevant pages from electrical specification showing occupancy sensors (if any), time clock (if any), lights and light fittings <u>Energy Report:</u> • 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

Table 11: Lighting parameters

6.3 Domestic Hot Water Supply

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. These items shall include, but not be limited to, groundwater or water recycling treatment plants.

Modelling Parameter	*Requirements*	*Documentation*
Domestic hot water loads	• Domestic hot water loads (to showers and wash hand basins) are to be calculated using the method outlined in Appendix D. • Note that any other hot water supply (such as for laundries) is not to be included.	Verification Documents: • Area schedule • Design or as-installed (where appropriate) specification of domestic hot water systems Energy Report: • Details of how the domestic hot water heating energy requirement is calculated in accordance with Appendix D.

Table 12: Domestic Hot Water parameters

6.4 Lifts, Escalators and Travelators

These items are entered separately into the calculator.

Modelling Parameter	*Requirements*	*Documentation*
Lift loads	• Lift loads are to be calculated using the method outlined in Appendix E.	Verification Documents: • Area schedule • Design or as-installed (where appropriate) 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 • Design or as-installed (where appropriate) specification of escalator and travelator systems Energy Report: • Details of how the escalator and travelator energy requirement is calculated

Table 13: Lifts, Escalator and Travelator parameters

7 Guidance for Use of Calculator

Green Star SA - Office Design v1

Energy Calculator

Points Achieved:	9
Ene-0 Conditional Requirement Result:	Achieved

Notes & Instructions

1. User must enter values into or select options in white cells ONLY
2. Refer to Green Star SA - Office v1 Energy Calculator & Modelling Protocol Guide for detailed information and assistance in using this calculator.

Please select compliance route adopted:	Compliance Route 1	
Route 1 - If Building is Naturally Ventilated: Is thermal comfort criteria met? (internal temperatures or PMV within specified limits for 90% of occupied hours)	n/a	
Route 2 - ASHRAE Advanced Energy Design Guide for Small Office Buildings: 'Deemed to Satisfy' route has been met? (non-modelling compliance route available for office buildings smaller than 2000m2 UA)	Not Available	(Area limit exceeded)
Route 3 - SANS 204:2008 'Deemed to Satisfy' route has been met? (prescriptive non-modelling compliance route available for all office buildings)	No; Route 1 used	

Office Usable Floor Area	33,000 m²
Total Car Parking Area	15,000 m²
Sub Basement Car Parking Area	500 m²
External Area (excluding Car Parking)	100 m²

Users must first select the compliance route which the project is using. In the case of naturally ventilated buildings, confirm whether the building thermal comfort criteria has been met (refer section on naturally ventilated buildings in this protocol for more information). If the building is not naturally ventilated, then 'n/a' must be selected.

The nominated areas given in the calculator are linked from the "Building Input" sheet.

ENERGY USE

	Notional SANS 204 Building	Actual Building	
	Electrical use kWh/year	Electrical use kWh/year	Gas use kWh/year
fuel CO_2 factor	1.2	1.2	0.202
Heating	97,000	69,300	
Cooling & Heat Rejection	1,155,000	825,000	
Pumps	512,820	366,300	
Fans	257,240	170,245	
Extract and Miscellaneous Fans	90,420	79,955	
Non Tenant Area Lighting	140,000	84,615	
Car Park Lighting	135,000	128,000	
External Lighting	600	850	
Lifts	90,000	84,615	
Domestic Hot Water	69,878	69,878	
Miscellaneous Equipment	-	-	
Lighting (tenant)	1,326,600	1,326,600	
Small Power (tenant)	2,547,600	2,547,600	
Supplementary Cooling (tenant)	115,500	115,500	
SUB TOTALS (kWh/year)	6,537,658	5,868,458	-

Note- efficient tenant lighting is rewarded by Green Star SA credits Ene-3 and Ene-4

For 'Compliance Route 1', enter the energy use predictions for both the notional building and the actual building (Note; for both 'Compliance Route 2' and 'Compliance Route 3', once either option is selected, no further input Is required and points are awarded automatically). The first

4 items should be obtained from the thermal simulation program, while other items should all be calculated as defined in this energy modelling protocol. If gas is used for heating or cooling (e.g. absorption chillers) then the amount of gas used should be entered in the third column. Gas used in cogeneration systems should not be entered here (it is entered later).

The calculator assumes that the tenant loads are the same in both the notional and actual building. The calculator also assumes that the tenant will install some supplementary cooling, estimated at 10% of the notional base building cooling load. This cooling is included purely to give a more realistic prediction of the total energy use of the building, and does not contribute to the final points allocated by the calculator, which are related to the base building emissions.

ON SITE RENEWABLE ELECTRICITY GENERATION (actual building only)				
	kWh/year	fuel factor $kgCO_2/kWh$	net saving $kgCO_2/year$	net saving $kgCO_2/m^2/year$
Renewable Electricity generated on site including photovoltaics, wind turbines etc.	50,000	0.0	60000.0	1.8

OTHER ON SITE GENERATION (actual building only)				
	kWh/year	fuel factor $kgCO_2/kWh$	net saving $kgCO_2/year$	net saving $kgCO_2/m^2/year$
Onsite Electricity Generation (e.g. electricity from a co-generation system)	1,000,000			
Type of fuel used	natural gas	0.20		
Amount of fuel used (calorific value in kWh)	3,000,000		594000.00	18.00

TOTALS		
Energy usage (notional building)	198.1	kWh/m²/year
Energy usage (actual building)	176.3	kWh/m²/year
Carbon emissions (notional building)	237.7	$kgCO_2/m^2/year$
Carbon emissions (actual building)	193.6	$kgCO_2/m^2/year$
Base Building Carbon emissions (notional building)	92.7	$kgCO_2/m^2/year$
Base Building Carbon emissions (actual building)	48.5	$kgCO_2/m^2/year$
PERCENTAGE IMPROVEMENT OVER NOTIONAL BUILDING	48%	

Energy Calculator Results (Compliance Route 1 only):	9

Back to Energy Credits

Any on site renewable electrical energy generated is entered here.

In the case of cogeneration systems, the amount of electricity generated and the amount of fuel consumed should be entered as in the example above. The amount of fuel can be calculated either from the manufacturer's information on consumption or else from the manufacturer's figure for the gross overall efficiency of the generator. Data must be provided to substantiate these figures.

The calculator displays the energy usage and carbon emissions of the notional and actual buildings to allow comparison. Finally the carbon emissions of the Base Building (i.e. not including tenant lighting, power and supplementary cooling) are compared and the percentage improvement figure used to calculate the number of points achieved.

8 Naturally Ventilated Buildings

The same (air conditioned) notional building is used for the assessment of both mechanically and naturally ventilated buildings, so that naturally ventilated buildings are compared fairly against other buildings and are rewarded for having lower carbon emissions. However, it is important that naturally ventilated buildings are comfortable and that reasonable temperatures are experienced during hot weather, or else it is likely that cooling will be retrofitted in the future, increasing the building's energy use. To minimise the risk of this future retrofit, all naturally ventilated buildings are required to meet the following criteria:

Thermal Analysis of all typical office spaces in the building, using hourly weather data must show that internal conditions are as follows:

- *Internal operative temperatures are within the 80% Acceptability Limits given in ASHRAE Standard 55-2004 for 90% of occupied hours in the year;   OR*
- *PMV (Predicted Mean Vote) levels are within -1.0 and +1.0 for 90% of occupied hours in the year.*

Refer the Green Star SA – Office v1 Technical Manual for more details of the ASHRAE operative temperature limits, and what variable to use when calculating PMV. Note that in Johannesburg and Cape Town, the operative temperature criteria will be satisfied if the internal temperature is never more than 1°C above the external temperature during hot weather.

If these criteria are not achieved, the building can still be submitted, but it must be modelled as if it had a cooling system maintaining an internal temperature of 24°C, and the energy required for cooling must be entered into the calculator.

It may be that in naturally ventilated and other buildings, very low energy-using tenant equipment (computers etc) are proposed with heat gains of under 11 W/m² in order to minimise overheating. Using lower figures can only be accepted at the discretion of the GBCSA and when supplemented with clear evidence that the equipment will be purchased (e.g. when the client is going to occupy the building (owner-occupier) and can show similar equipment installed in another office).

Note that the tenant energy uses (lighting, power) are not included in the energy comparison, but will have an effect in terms of comfort levels in naturally ventilated buildings. Therefore, deviations from the standard assumptions will only be accepted in exceptional cases.

9 Renewable Energy and Cogeneration

9.1 Electrical Energy from on site renewable generation

Any electrical energy generated on site from "renewable" sources (e.g. photovoltaics, wind turbines, etc) is subtracted from the total electrical energy use of the building, whether or not the energy is used on site or exported. Purchase of "green electricity" does not qualify for this section and should not be entered.

9.2 Electrical Energy from on site non-renewable generation (e.g. cogeneration)

The annual fuel used for the generation is entered into the first part of the calculator. The associated electrical energy generated is then subtracted from the total electrical energy consumption of the building. If a conventional generator is proposed to be run using "low carbon" fuel (e.g. biodiesel) the carbon factor for biodiesel can only be used if there is clear evidence that a procurement strategy is in place for the purchase of the fuel or that the equipment has been modified so that it will only be able to operate with the low carbon fuel. In all other cases, conventional fuel must be assumed.

9.3 Heat Energy from low carbon sources (e.g. cogeneration and solar)

Any heat generated from renewable sources (e.g. solar water heating) should be subtracted from the heat energy use required for the building and SHOULD NOT BE ENTERED INTO THE CALCULATOR. This energy is treated as carbon neutral.

If a cogeneration (CHP) system is to be installed, the fuel should be included in the third part of the calculator ("Other On Site Generation," as described above). Any heat obtained from the cogeneration plant is then assumed to be "carbon free". If this heat is to be used on site, then the heat energy which is served from the cogeneration plant should not be included in the heat energy use required for the building and SHOULD NOT BE ENTERED INTO THE CALCULATOR. The designer should confirm that an analysis has been carried out to ensure that the heat demand coincides with times when the cogeneration plant will be in operation and that peak demands are within the capacity of the cogeneration plant.

10 Fuel CO2 factors

An average fuel factor for South African mains electricity is used by the calculator, which is defined as 1.2kgCO2/kWh by ESKOM[2], a relatively high figure due to the large number of coal fired power stations. As newer, more efficient power stations are built, it will be necessary to revise the fuel factors in future Green Star SA tool and versions.

[2] ESKOM Annual Report 2007, footnote to Table 3 ENVIRONMENTAL IMPLICATIONS OF USING/SAVING ONE KILOWATT-HOUR OF ELECTRICITY, page 189

APPENDIX A

SIMULATION BRIEF FOR ASSESSORS

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

- The simulation package has passed external validation standards such as BESTEST ;
- The model analyses building performance on an hourly basis for a full year;
- Two buildings have been modelled – the Notional building and the Actual building;
- The Notional building model has the correct assumptions on building fabric and HVAC systems, and has the same occupancy, equipment, lighting etc as the Actual building;
- The Actual building model accurately represents:
  - Glazing on the building – whether the model represents glazing as only a U-value and shading coefficient;
  - The proposed HVAC system;
  - The HVAC controls which are to be used;
  - The performance curves and sizes for plant items;
- Sample performance curves are provided for cooling and heating sources (fans, pumps, chillers, etc.)
- All other aspects of the building have been modelled correctly, with no significant compromises made.

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

APPENDIX B

SPACE TYPE DEFINITIONS

The following provides definitions of the space types used within the Green Star SA – Office v1 rating tool Energy Calculator.

- Commercial Office Area – These spaces include all office areas, reception, meeting rooms, breakout space.
- Car Parks - These spaces include areas specifically designated for car parking, both internal and external.

APPENDIX C
OFFICE PROFILES

Time	Occupancy	Lighting	Lighting (with controls)*	Lighting (with controls and occupancy sensors)+	Equipment	HVAC plant
0 to 1	0%	15%	5%	5%	50%	off
1 to 2	0%	15%	5%	5%	50%	off
2 to 3	0%	15%	5%	5%	50%	off
3 to 4	0%	15%	5%	5%	50%	off
4 to 5	0%	15%	5%	5%	50%	off
5 to 6	0%	15%	5%	5%	50%	off
6 to 7	0%	15%	5%	5%	50%	off
7 to 8	15%	40%	30%	27%	65%	on
8 to 9	60%	90%	75%	68%	80%	on
9 to 10	100%	100%	100%	90%	100%	on
10 to 11	100%	100%	100%	90%	100%	on
11 to 12	100%	100%	100%	90%	100%	on
12 to 13	100%	100%	100%	90%	100%	on
13 to 14	100%	100%	100%	90%	100%	on
14 to 15	100%	100%	100%	90%	100%	on
15 to 16	100%	100%	100%	90%	100%	on
16 to 17	100%	100%	100%	90%	100%	on
17 to 18	50%	80%	75%	68%	80%	on
18 to 19	15%	60%	25%	23%	65%	off
19 to 20	5%	60%	15%	14%	55%	off
20 to 21	5%	50%	15%	14%	55%	off
21 to 22	0%	15%	5%	5%	50%	off
22 to 23	0%	15%	5%	5%	50%	off
23 to 0	0%	15%	5%	5%	50%	off

Table 14: Office Weekday Profile

Notes
* Lighting controls must satisfy the Ene-4 credit criteria in order to use this profile
+ Lighting controls must satisfy the Ene-4 credit criteria, and presence/absence detectors must be provided at least every 45m² to use this profile

Time	Occupancy	Lighting	Lighting (with controls)*	Lighting (with controls and occupancy sensors)+	Equipment	HVAC plant
0 to 1	0%	15%	5%	5%	50%	off
1 to 2	0%	15%	5%	5%	50%	off
2 to 3	0%	15%	5%	5%	50%	off
3 to 4	0%	15%	5%	5%	50%	off
4 to 5	0%	15%	5%	5%	50%	off
5 to 6	0%	15%	5%	5%	50%	off
6 to 7	0%	15%	5%	5%	50%	off
7 to 8	0%	15%	5%	5%	50%	off
8 to 9	5%	25%	15%	14%	55%	off
9 to 10	5%	25%	15%	14%	55%	on
10 to 11	5%	25%	15%	14%	55%	on
11 to 12	5%	25%	15%	14%	55%	on
12 to 13	5%	25%	15%	14%	55%	off
13 to 14	5%	25%	15%	14%	55%	off
14 to 15	5%	25%	15%	14%	55%	off
15 to 16	5%	25%	15%	14%	55%	off
16 to 17	5%	25%	15%	14%	55%	off
17 to 18	0%	15%	5%	5%	50%	off
18 to 19	0%	15%	5%	5%	50%	off
19 to 20	0%	15%	5%	5%	50%	off
20 to 21	0%	15%	5%	5%	50%	off
21 to 22	0%	15%	5%	5%	50%	off
22 to 23	0%	15%	5%	5%	50%	off
23 to 0	0%	15%	5%	5%	50%	off

Table 15: Office Saturday Profile

Notes
* Lighting controls must satisfy the Ene-4 credit criteria in order to use this profile
+ Lighting controls must satisfy the Ene-4 credit criteria, and presence/absence detectors must be provided at least every 45m² to use this profile

Time	Occupancy	Lighting	Lighting (with controls*)	Lighting (with controls and occupancy sensors+)	Equipment	HVAC plant
0 to 1	0%	15%	5%	5%	50%	off
1 to 2	0%	15%	5%	5%	50%	off
2 to 3	0%	15%	5%	5%	50%	off
3 to 4	0%	15%	5%	5%	50%	off
4 to 5	0%	15%	5%	5%	50%	off
5 to 6	0%	15%	5%	5%	50%	off
6 to 7	0%	15%	5%	5%	50%	off
7 to 8	0%	15%	5%	5%	50%	off
8 to 9	5%	25%	15%	14%	55%	off
9 to 10	5%	25%	15%	14%	55%	off
10 to 11	5%	25%	15%	14%	55%	off
11 to 12	5%	25%	15%	14%	55%	off
12 to 13	5%	25%	15%	14%	55%	off
13 to 14	5%	25%	15%	14%	55%	off
14 to 15	5%	25%	15%	14%	55%	off
15 to 16	5%	25%	15%	14%	55%	off
16 to 17	5%	25%	15%	14%	55%	off
17 to 18	0%	15%	5%	5%	50%	off
18 to 19	0%	15%	5%	5%	50%	off
19 to 20	0%	15%	5%	5%	50%	off
20 to 21	0%	15%	5%	5%	50%	off
21 to 22	0%	15%	5%	5%	50%	off
22 to 23	0%	15%	5%	5%	50%	off
23 to 0	0%	15%	5%	5%	50%	off

Table 16: Office Sunday and Public Holiday Profile

Notes
* Lighting controls must satisfy the Ene-4 credit criteria in order to use this profile
+ Lighting controls must satisfy the Ene-4 credit criteria, and presence/absence detectors must be provided at least every 45m² to use this profile

Car Parks & External Areas

When calculating the energy consumption of the lighting and ventilation in the car park area, the following profiles should be used in conjunction with the actual lighting power requirements as per the lighting specifications.

Time	Car Park			External Lighting (timeclock/ photocell)	External Lighting (photocell and presence control*)
	Internal lighting	Internal lighting with presence controls*	Plant		
0 to 1	5%	5%	Off	100%	10%
1 to 2	5%	5%	Off	100%	10%
2 to 3	5%	5%	Off	100%	10%
3 to 4	5%	5%	Off	100%	10%
4 to 5	5%	5%	Off	100%	100%
5 to 6	5%	5%	Off	100%	100%
6 to 7	5%	5%	Off	0%	0%
7 to 8	100%	90%	On	0%	0%
8 to 9	100%	90%	On	0%	0%
9 to 10	100%	90%	On	0%	0%
10 to 11	100%	50%	On	0%	0%
11 to 12	100%	50%	On	0%	0%
12 to 13	100%	90%	On	0%	0%
13 to 14	100%	90%	On	0%	0%
14 to 15	100%	40%	On	0%	0%
15 to 16	100%	40%	On	0%	0%
16 to 17	100%	90%	On	0%	0%
17 to 18	100%	90%	On	100%	100%
18 to 19	100%	50%	On	100%	100%
19 to 20	5%	5%	Off	100%	50%
20 to 21	5%	5%	Off	100%	10%
21 to 22	5%	5%	Off	100%	10%
22 to 23	5%	5%	Off	100%	10%
23 to 0	5%	5%	Off	100%	10%

Table 17: Car Parks and External Lighting Profiles

Notes
* Lights must be controlled with individual presence detectors or else in groups covering no more than 45m² area per presence detector to use this profile.

APPENDIX D
HOT WATER ENERGY USE

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 no hot water energy consumption associated with car parks.

The calculator currently assesses the efficiency of the hot water system rather than how much hot water is being used, and a fixed estimate of hot water is used independent of the type of fittings.

	Domestic hot water supply (at 60°C) (L/m²/day)
Office	0.15
Car Parks	0

Table 18: Benchmarks for hot water energy consumption

Protocol for calculating energy use

1. Calculate the **Daily Domestic Hot Water Requirements** by multiplying the hot water supply (L/m²/day) found in the table above by each of the space type areas (m²).

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 Office 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.

   The Energy required to heat water can be found using the formula

   $$\text{Energy (in Joules)} = m\, c\, \Delta T / \varepsilon$$

   Where m = mass of water in kg (= volume of water in litres)
   c = specific heat capacity of water = 4200 J/kg/K
   ΔT = change in temperature of the water in °C
   ε = overall system efficiency

   The energy (in kWh) can then be obtained by dividing this result by (1 kWh = 3 600 000 joules)

3. Multiply the Daily Domestic Hot Water Energy Requirement by 260 days to calculate the Yearly Hot Water Energy Requirement.

4. Any heat generated from renewable sources (e.g. solar water heating) should not be included in the energy requirement figure identified above. This energy is treated as carbon neutral.

5. The energy requirement in kWh should then be entered into the energy calculator into the electrical and/or gas columns as appropriate depending on the fuel source for the hot water heating system as designed.

Example (yellow section to be calculated by user)

WATER SUPPLIED TO:	HOT WATER REQUIRE-MENTS (L/m²/ day)	TOTAL AREA (m²)	HOT WATER REQUIRE-MENTS (L/day)	DAILY ENERGY REQUIRED (ELECTRIC) kWh/day	DAILY ENERGY REQUIRED (GAS) kWh/day	YEARLY ENERGY REQUIRED (ELECTRIC) kWh/year	YEARLY ENERGY REQUIRED (GAS) kWh/year
Office	0.15	2500	375	26.7	0	6951	0

Table 19: Example to how to calculate hot water energy consumption – building with electric water heaters and efficiency of 90%

The figures to be entered into the Energy Calculator are 6591 for electric and 0 for gas.

The notional building energy use is calculated by the excel tool as follows
The same volume of hot water is assumed (i.e. 0.15 l/m^2/day) to be heated electrically (efficiency 90% to allow for some distribution losses).

Hot water energy usage in Joules is:
m^3 of water x (1 m^3 = 1000 kg) x specific heat capacity (=4200 J/kg/K) x temp difference (=55 °C assuming a cold water temperature of 5°C) x 260 days / 0.9 efficiency factor

Joules are then converted to kWh by dividing by (1 kWh = 3 600 000 joules).

APPENDIX E

LIFT ENERGY USE

To calculate actual lift energy use:

1. Determine the lift power ratings **R** in kW from supplier specifications.

2. Determine the **S**tandby power from car lights and lift control system in kW from supplier specifications.

3. Calculate the **Yearly Energy Usage** using the following formula, and the data in the table below.

$$E = \frac{R \times S \times T}{3600} + S_t \times 18 \times 260$$

Where:

E = annual **E**nergy usage (kWh/year)
R = Power **R**ating of the motor (kW)
S = number of **S**tarts per year
T = typical **T**rip time (seconds)
S_t = standby power – car lights and lift control systems (kW)

Note that:

- 3600 takes the first half of the equation, which is in kW seconds, and coverts it to kWh
- The 18 x 260 takes the standby power and multiplies it by operational hours and days in a year to get annual energy consumption.

Building Type	Standard Number of Starts per Year S	Typical Trip Time T
Office	300,000	5 seconds

4. Elevators lacking a power-off feature for standby mode need to assume an additional **6 hours of standby operation** each day (x 260 days per year) to compensate for a less efficient design.

5. Elevators with speeds over 2.5 m/s lacking regenerative brakes need to assume an additional **15% on the total energy consumption** to compensate for a less efficient design.

6. If a lift only services 3 floors, is to solely be used as a disabled lift and is labelled as such, the energy consumption of this lift can be discounted by 90%.

7. Multiply by the number of lifts

8. This procedure calculates the **total yearly energy usage**. This number is the figure to be entered into the **Energy Calculator**.

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

Equation Symbol	Description	Lift
R	Lift Power Rating (kW)	5
S_t	Standby Power Rating (kW)	0.1
S	Number of starts per year	300,000
T	Typical Trip Time(s)	5
E	Yearly Energy Usage (kWh/yr)	2,551
	Penalty for lack of power off feature (kW)	0.1 x 6 x 260 = 156
	Penalty factor for lack of regenerated power feedback	0% (lift max speed 1.5m/s)
	Weighted yearly energy usage per lift (kWh/yr)	(2,551 + 156) x (1 + 0) = 2,707
	Number of lifts of this type	3
	Total yearly energy usage (kWh/yr)	2,707 x 3 = 8,121

Table 20: Example of how to calculate lift energy consumption

To calculate notional building lift energy use:
The same number of lifts must be assumed as in the actual building, with the same number a disabled lifts etc. Each lift should be assumed to have a power rating of R = 5 kW and standby power rating of S_t = 0.1 kW. Lifts should be assumed not to have a power-off feature, and to be under 2.5m/s so no correction for regenerative braking is required. These ratings are based on typical electric traction lifts.

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 no sensor.

3. Calculate the **Yearly Energy Usage**. This calculation 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 number is the figure to be entered into the **Green Star SA – Office v1 Energy Calculator**.

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

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 21: Example of how to calculate escalator or travelator energy consumption

To calculate notional building escalator/travelator energy use:

Assume that the notional office building does not contain escalators or travelators

APPENDIX F
DAYLIGHT DIMMING

Protocol for calculating HVAC energy reduction due to daylight dimming

Due to the complexity of modelling, a reduction in HVAC loads due to daylight dimming or switching should only be included if there will be a substantial reduction compared to the base case (i.e. greater than 2% of total energy consumption).

The calculation methodology for use of daylight dimming or switching should be submitted to the GBCSA via a CIR (credit interpretation request) prior to submission.

APPENDIX G

ENERGY MODELLING REPORT FORMAT

It is recommended that the Energy Modelling Report be submitted in the following format (refer to the sections 5 and 6 for details of what should be included in each part). The text *in italics* illustrates where the user should enter details of the project.

General Modelling Parameters

- Project *XYZ Office*
- Number of Stories *2*
- Location *Johannesburg*
- Simulation Software Used *DesignBuilder v1.4*
- Weather Data Used *Meteonorm O.R.Tambo/Jan Smuts Airport 1996-2005*
- Space Breakdown

Space	**Type**	**Included in simulation?**	**Area (m²)**	**Comments**
Reception	*Office*	*yes*	*240*	
Office – ground floor	*Office*	*yes*	*650*	
Office – first floor	*Office*	*yes*	*900*	
Photocopy area	*Office*	*yes*	*15*	*extract calculated manually*
Car Park (external)	*n/a*	*no*	*650*	*lighting energy use calculated manually*
Plant room	*n/a*	*no*	*40*	*lighting and extract vent energy use calculated manually*
Laundry	*n/a*	*no*	*42*	*lighting included, laundry equipment excluded*
TOTAL			*2537*	

[Justification for any areas of the project excluded from the model]

- Central Plant

[Details of any central plant which serves areas other than the modelled area, and how these have been dealt with]

Naturally Ventilated Buildings

[Confirmation that the Natural ventilation comfort criteria has been met or not, and details of modelling to show compliance – either in the energy modelling report or as a separate Natural Ventilation Report – refer Green Star SA Technical Manual – credit Ene-1]

Building Envelope

- Geometry

[Isometrics of the simulation model for both the Actual and the Notional Building showing the building shape and window locations, etc, that allows easy comparison with architectural drawings]

- Fabric

	Notional Building	**Actual Building**
Exterior Wall Construction	*Insulated R=2.2*	*brick, cavity, insulation, block R = 2.5*
Roof	*Insulated R= 2.7*	*tile, membrane, void, insulation R = 2.7*
Floor	*150mm slab with carpet*	*150mm slab with carpet*

- Glazing

	Notional Building	**Actual Building**
Window Type	*SANS 204 minimum standard*	*Double, Timber frame, solar coating*
Window area (m^2)	*132*	*102*
Average U value including frame	*5.6*	*2.2*
SHGC	*0.77*	*0.51*
Visual light transmittance	*0.8*	*0.7*

	Notional Building	**Actual Building**
Rooflight Type	*SANS 204 minimum standard*	*Double, Timber frame, solar coating*
Rooflight area (m^2)	*14*	*0*
Average U value including frame	*2.5*	*n/a*
SHGC	*0.35*	*n/a*
Visual light transmittance	*0.4*	*n/a*

- Shading

[Details of internal and external shading included in simulation]

- Orientation

  [Evidence that orientation of the building has been taken into account]

- Infiltration

	Notional Building	**Actual Building**
Infiltration rate	*0.5ach*	*0.5ach*

Internal Loads

	Notional Building	**Actual Building**
Summer design temperature	*24°C*	*24°C*
Winter design temperature	*20°C*	*20°C*
Occupancy	*15 m²/person*	*15 m²/person*
Tenant lighting	*12 W/m²*	*12 W/m²*
Tenant equipment	*11 W/m²*	*11 W/m²*
Fresh air rate	*8 litres/sec/person*	*10 litres/sec/person*

[A graphic from the simulation package showing a typical day with the load profiles, to demonstrate that the profiles given in Appendix C have been used]

HVAC Systems

- System design

  [Description of the HVAC system, including number and kW rating of chillers, plant efficiency (COP) etc, number and duty of air handling units etc]

- Zoning

  [Diagrams of zones used]

- Chilled water, condensing water etc

  [Details of results of simulation for each piece of plant showing how these relate to the numbers entered into the calculator]

- Controls

  [Details of controls assumed when modelling plant]

- Simulation Energy Usage results

  [Details of results of simulation for each piece of plant showing how these relate to the numbers entered into the calculator]

Extract and Miscellaneous Fans

[Details of car park and miscellaneous extract fans energy use]

Lighting

[Details of tenant and non-tenant lighting, car park and external lighting calculations. Where occupancy sensors or other controls are assumed giving full details]

Domestic Hot Water

[Calculation laid out as Appendix D]

Lifts & Escalators

[Calculation laid out as Appendix E]

Renewable Energy & Cogeneration

[Full details of systems proposed, and how annual energy consumption/generation figures have been calculated]

Modelling Errors/Simplifications

[Full details of any warnings obtained when running the software, or any defaults which have been overridden (for example number of hours when the stated internal design temperatures were not achieved)]

Sign off

[Confirmation of name and company of person carrying out the modelling, and signed confirmation that they believe the results to be accurate to the best of their knowledge]