Green Star SA – Retail Centre v1

ENERGY CALCULATOR & MODELLING PROTOCOL GUIDE – VERSION 1.1

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1 Executive Summary

The Green Star SA – Retail Centre v1 rating tool has been developed to evaluate the predicted performance of retail centres based on a variety of environmental criteria. The Energy Calculator within this tool compares the predicted energy consumption of a retail centre to a benchmark based on a notional (reference) building complying with various standards and schedules (including aspects of 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 notional building 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 retail centre facilities.

The predicted ancillary load energy consumption, such as that from lighting, mechanical ventilation, domestic hot water and vertical transportation, 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. The lighting energy can either be an output of the energy model or calculated using the lighting energy calculator, or a combination of both.

Finally, this guide includes information on how to enter the simulation outputs and the ancillary load calculations into the Green Star SA – Retail Centre 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

The Green Building Council of South Africa acknowledges the work of technical consultant WSP Group in development of the Energy Calculator & Modelling Methodology for the South African Green Star SA – Retail Centre v1 tool.

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 – Retail Centre v1 rating tool assesses the environmental performance of retail centres by measuring their environmental impact. Part of this assessment includes determining the predicted energy consumption of the retail centre.

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 (which can also include lighting energy). 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 (reference) 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 mechanical and electrical systems performance. The building must be modelled in accordance with the requirements and specifications for the notional building as put forward in this document.

4.2 Model Actual Building

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

4.3 Enter energy use into Green Star SA – Retail Centre v1 energy calculator

The 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.

4.4 Nominated area definitions relevant to the energy calculator

HVAC and other services installations are not all always designed and directed by the landlord/developer's professional team, and are sometimes designed and directed by the tenants themselves. The developer/landlord is thus only in control of design for such tenants that his professional team is responsible for, and can thus claim potential Green Star SA points under the Green Star SA – Retail Centre v1 which rates the base building attributes. For this reason it is necessary to define nominated areas which are defined according to the area that the developer/landlord's professional team are in control of.

Nominated Area (HVAC) - In terms of the HVAC system, the nominated area must include all common areas and the tenant HVAC systems (including potential naturally ventilated systems) that are designed by the landlord/developer's mechanical engineer, i.e. it would exclude all tenants that design their own HVAC systems. In cases where the landlord/developer has the responsibility for only parts of the design of a tenant's HVAC system (for example chilled water), the HVAC system for that tenant should be excluded from the energy model (and also excluded from the nominated area) – the nominated area must only include systems that are in totality under the landlord/developer's mechanical engineer' control. This nominated area is as per the nominated area defined in the IEQ category mechanical/HVAC design related credits. For the purposes of this tool this area is called '*Nominated Area (HVAC)*'.

Nominated Area (Lighting) - The nominated area for the lighting energy must relate to the area of the lighting design under the control of the landlord/developer's electrical engineer. For the purposes of this tool this area is called '*Nominated Area (Lighting)*'. This area can only include tenancies/areas where all base building lighting design in the specific tenancy/area is adequate (according to South African standards) and under the control of the landlord/developer's electrical engineer. Tenants might add lighting afterwards, but this should not be included in the calculations, as this tool assesses only the base building attributes. Documentation must be provided with the submission of the base building lighting design which the landlord's electrical engineer has designed. **Please refer to Appendix B for further definitions.**

5 Guidelines for Modelling Parameters

The parameters for simulation of energy consumption of a retail centre are given in this section. These are standard criteria that must be adhered to in ordered to comply with the Green Star SA – Retail Centre v1 Energy credit 1 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 in the Energy Report 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 demonstrate that leaving it out in both the notional and actual building models is a conservative approach (i.e. showing that leaving it out gives a higher energy consumption in the actual building).	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 (reference) Building	Actual Building
Geometry	Geometry based on actual geometry of building	Geometry based on actual geometry of building
Fabric	Fabric as follows: • Glazing System: Windows to have a U value 7.9 and a Solar Heat Gain Factor (SHGF) of 0.81 (based on clear single glazing, aluminium framed window taken from SANS204:2008 part 3 Table 6). *The glazing geometry and areas should be the same in both buildings (notional and actual).* • Walls insulated to R = 2.2 ('walls' refers to all vertical opaque surfaces, including walls, spandrels and doors) • Roof insulated to R = 2.7 to 3.7 depending on climatic zone – confirm using SANS204:2008 part 3. This R value would also apply to any atrium (including roof glazing) in the notional building. • Floor: specify the same floor structure and cross section as the actual building.	• Glazing System: Window U values to be modelled as per actual (Glass, frame and divider combined U value to be used). The glazing geometry and areas should be the same in both buildings (notional and actual). • Fabric to be modelled as per actual fabric (R values) • Floor: notional and actual building floor specification to be the same.
Orientation	Use actual orientation.	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.	<u>Verification Documents:</u> • Design or as-installed (where appropriate) relevant architectural drawings. <u>Energy Report:</u> • 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.	<u>Verification Documents:</u> • Design or as-installed (where appropriate) relevant architectural drawings. • Design or as-installed (where appropriate) materials schedule. <u>Energy Report:</u> • 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.	<u>Verification Documents:</u> • Design or as-installed (where appropriate) relevant pages from the glazing or façade specification. <u>Energy Report:</u> • Details of how glazing has been modelled.
Windows and Spandrel	• Demonstrate that the sizes of windows and spandrel are accurately represented.	<u>Verification Documents:</u> • Design or as-installed (where appropriate) relevant architectural drawings. <u>Energy Report:</u> • 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	• Set the infiltration rate to 0 for both models. • In the notional building all internal and external doors are to be modelled as closed, and in the actual building all internal and external doors are to be modelled as open unless it can be shown that automatic door closers or rotating doors are designed for.	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 showing that infiltration has been set to zero in both models.

Table 3: Building envelope parameters - general

5.3 Internal Design Criteria

	Notional (reference) Building	Actual Building
Internal design temperatures	24°C in summer 20°C in winter	as client brief or if no client brief than as per notional building
Occupancy	1 person per 20m²	1 person per 20m² (even if client brief is higher/lower)
Lighting (in tenant areas)	17 W/m² (based on a 25% improvement on the SANS204:2008 Table 14)	17 W/m² or as actual design (refer to lighting schedules)
Lighting (Non Tenant Area Lighting - mall & public common spaces)	12 W/m²	12 W/m² or as actual design (refer to lighting schedules)
Lighting (Non Tenant Area Lighting - non-public spaces - 'back of house')	5 W/m²	5 W/m² or as actual design (refer to lighting schedules)
Lighting (car park and external areas)	Do not form part of model.	Do not form part of model.
Equipment (in tenant areas)	0 W/m²	0 W/m²
Fresh Air rate	Actual design rate or 5 litres/sec/person (as per SANS 10400), 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 operational profiles (see Appendix C) have been used in the 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	• Because equipment loads in the retail context differ significantly from tenant to tenant, they are to be taken as $0W/m^2$ for both the actual and notional building.	Energy Report: • Details of how the equipment load densities have been modelled as $0w/m^2$.
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); and/or,
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 (reference) 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 such as to allow for 'Variable air volume (VAV) systems which, during periods of occupancy are designed to reduce the air supply to each zone to a minimum before re-heating, re-cooling or mixing takes place. This minimum volume should be no greater than 30 % of the peak supply volume.' (as taken from SANS 204 4.8.7.3.3(a)) – note that 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 (so that the air density can be calculated). 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 for the nominated area. • Where the nominated area includes open air malls or open air courtyards that can be classified as part of the mall, the notional building model must model this space as a conditioned internal space, and the actual building model as per the actual unconditioned space.	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 (where an index run refers to the duct (or 'run') with the highest pressure drop).	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 • Demonstrate that set points have been rescheduled as specified. Note that simplifications may be made to consider average zone temperature in lieu of high/low select.	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 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 – refer also to Appendix C for the applicable operating profiles of the items below.

	Notional SANS204 Building	Actual Building
Car Park Ventilation	Assume no energy use for car parking on first basement (B1) levels and above (i.e. 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 equipment/plant 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 internal areas

All lighting usage and energy should be calculated either manually (via the lighting energy calculator) or using the computer simulation modelled numbers which must be entered into the lighting energy calculator (or a combination of simulated and manually calculated values may be entered) – these values are automatically transferred into the energy calculator by the excel tool. The relevant lighting operation control schedules (profiles as given in Appendix C) must be selected and applied either in the computer model or in the lighting energy calculator. 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/heating as well as the actual lighting energy loads of the building. For daylight dimming refer Appendix F.

Lighting in external areas

The energy use associated with all lighting in external areas should be calculated and entered into the lighting energy calculator, which are automatically transferred it to the energy calculator. The energy consumption calculation should be based on a calculation of the actual number of fittings used and the power ratings of each fitting, together with the consumption profiles given in Appendix C – select 'modelled' under the schedule drop down options to allow the Lighting Energy Calculator to use your calculated energy consumption. If this is not done, the calculator will assume that the lit areas and W/m^2 values are the same for the notional and actual external site area. 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.

Refer to Appendix B for further detail on the lighting area definitions.

Modelling Parameter	*Requirements*	*Documentation*
Lighting	• 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: • Controls – where it can be justified with design documentation, the Lighting (with controls) profile may be used. • Time Clocks/Photocell: If external lighting operates on a time clock or photocell, then the External Lighting (timeclock/ photocell) profile must be used. • Presence/Absence sensors: Where presence detectors are provided at least every 60m² of floor area, the profile Lighting (with controls and occupancy sensors) may be used. • Daylight dimming: Details on this system, and the calculation method must be provided. The calculation must use the methodology outlined in Appendix F.	Verification Documents: • 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 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

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.	<u>Verification Documents:</u> • Area schedule • Design or as-installed (where appropriate) specification of domestic hot water systems <u>Energy Report:</u> • 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 Vertical Transportation

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 - Retail Centre v1

Energy Calculator

Notes & Instructions:

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

Points Achieved:	**13**
Ene-0 Conditional Requirement Result:	**Achieved**

Please select Compliance Route adopted:	**Compliance Route 1**
Route 1 - If Building is Naturally Ventilated: Is thermal comfort criteria met? (Thermal comfort requirements need to be met to accept this as an option - refer to the Technical Manual for details)	**n/a (no Nat. Vent.)**
Route 2 - ASHRAE *Advanced Energy Design Guide for Small Retail Buildings:* 'deemed to satisfy' route has been met? (non modelling compliance route available for retail centres smaller than 2200m2)	**Not Available** *(Retail GFA limit exceeded)*

Retail Gross Floor Area	13,750 m²
Total Retail Tenant Floor Area	10,000 m²
Nominated Area (HVAC) related to certain IEQ credits in m² (including common areas):	8,500 m²
Nominated Area (Lighting) related to certain Ene-1 in m² (excludes common areas):	2,500 m²
Non Tenant Area Lighting (mall & public common spaces)	3,600 m²
Non Tenant Area Lighting (non-public spaces - 'back of house')	1,200 m²
Total Internal Covered Car Parking Area	4,500 m²
External Area (including external Car Parking)	500 m²

The compliance path for the Energy Conditional Requirement is selected on the main Energy category worksheet. Confirmation of whether the ASHRAE requirement has been met for buildings smaller than 2,200m^2 is automatically linked from the Energy category worksheet Conditional Requirement choice. The calculator will automatically score 2 points if the ASHRAE deemed to satisfy route is selected.

In the case of naturally ventilated buildings, confirm whether the building thermal comfort criteria has been met (refer to section on naturally ventilated buildings in this protocol for more information).

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

ENERGY USE — Go To Lighting Energy Calculator

	Notional Building	Actual Building		
	Electrical use kWh/year	Electrical use kWh/year	Gas use kWh/year	
fuel CO_2 factor	1.20	1.20	0.20	
Heating (nominated area)	50,000	35,000		modelling data for nom. area (notional & actual buildings)
Cooling & Heat Rejection (nominated area)	200,000	200,000		modelling data for nom. area (notional & actual buildings)
Pumps (nominated area)	20,000	10,000		modelling data for nom. area (notional & actual buildings)
Fans (nominated area)	10,000	4,566		modelling data for nom. area (notional & actual buildings)
Extract and Miscellaneous Fans (nominated area)	2,000	456		modelling data for nom. area (notional & actual buildings)
Tenant Area Lighting (included within the nominated area (lighting))	286,195	0		refer to 'Lighting Energy Calculator'
Non Tenant Area Lighting (mall & public common spaces)	377,395	0		refer to 'Lighting Energy Calculator'
Non Tenant Area Lighting (non-public spaces - 'back of house')	52,416	0		refer to 'Lighting Energy Calculator'
Internal Covered Car Park Lighting	196,560	0		refer to 'Lighting Energy Calculator'
External Lighting (including parking, and not covered by any of the above)	7,098	0		refer to 'Lighting Energy Calculator'
Vertical transportation	100	100		calculate for Retail GFA (notional & actual building)
Domestic Hot Water	275,341	225,000		calculate for Retail GFA (notional & actual building)
SUB TOTALS for NOMINATED AREA & ANCILLARY (kWh/year)	**1,477,105**	**475,122**	-	
Lighting for non-nominated area tenant area	553,796	553,796		
HVAC for non-nominated area tenant area	301,579	301,579		calculated to give the user an overall comparison
SUB TOTALS for BASE BUILDING (kWh/year)	**1,778,685**	**776,701**	-	

Enter the energy use predictions for both the notional building and the actual building. The first 5 items should be obtained from the thermal simulation program, while other items should all be calculated as defined in this 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).

Lighting loads must be entered via the 'Lighting Energy Calculator', either by entering the values from the actual energy model, or by entering the W/m^2 values per area, using a selected lighting control schedule, or a combination of both. The notional building lighting energy is calculated by the 'Lighting Energy Calculator.' All lighting energy values are automatically brought forward to the Energy Calculator.

Energy Usage for vertical transportation and domestic hot water must be calculated for the actual and the notional building as per this protocol.

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.	100,000	0	120,000	9

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)	100,000			
Type of fuel used	Natural gas	0.202		
Amount of fuel used (calorific value in kWh)			120000	8.727272727

TOTALS		
Energy usage (notional building) - including nominated, non-nominated, parking & external areas	129	kWh/m²/year
Energy usage (actual building) - including nominated, non-nominated, parking & external areas	49	kWh/m²/year
Carbon emissions (notional building)	155	$kgCO_2/m^2$/year
Carbon emissions (actual building)	50	$kgCO_2/m^2$/year
PERCENTAGE IMPROVEMENT OVER NOTIONAL BUILDING	67.6%	

Energy Calculator Results (Compliance Route 1 only):	**13**

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, of the entire Base Building (i.e. including nominated and non-nominated tenant lighting and HVAC) 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 must demonstrate that the IEQ-9 Thermal Comfort credits are met (where relevant to the naturally ventilated area).

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 CO_2 factors

An average fuel factor for South African mains electricity is used by the calculator, which is defined as 1.2kgCO_2/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.

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[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.
- All assumptions that are made must be conservative.

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

APPENDIX B

SPACE TYPE DEFINITIONS & GLOSSARY

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

- Retail Gross Floor Area – These spaces include all retail areas, including public and back of house common areas that form part of the Gross Floor Area.
- Nominated Area – the nominated area as related to certain IEQ and Energy category credits refers to the area for which the landlord/developer's engineers are in control of the base building HVAC and lighting design – it excludes tenant spaces that provide HVAC and lighting according to their own design.
- Back of House area: this is non-public common area, typically for escape passages or service access.
- Mall area: this area is area that is dedicated to circulation, and can be conditioned, naturally ventilated or open air, which shopfronts open onto. For the sake of this methodology food courts can be considered part of the mall area.
- Car Parks - These spaces include areas specifically designated for car parking, both internal and external. Note specific definitions relating to the Lighting Energy Calculator highlighted below.
- Actual or Proposed Building – the building as designed and modelled by the project team
- Notional or Reference Building – a hypothetical building of the same shape and form as the actual building, but with fenestration, building fabric and building services as specified by this protocol. .

<u>Areas in the Lighting Energy Calculator:</u>

Tenant Area Lighting (included within the nominated area (lighting))
Non Tenant Area Lighting (mall & public common spaces)
Non Tenant Area Lighting (non-public spaces - 'back of house')
Internal Covered Car Park Lighting
External Lighting (including parking, and not covered by any of the above)

Tenant Area Lighting: This is the area of the lighting design under the control of the landlord/developer's electrical engineer. This area can only include tenancies/areas where all lighting design in the specific tenancy/area is under the control of the landlord/developer's electrical engineer, and not where tenants will add lighting according to their own design over and above the landlord/developer's electrical engineer's design.

Non Tenant Area Lighting (mall & public common spaces): This is the lighting to all mall areas and public common areas (to which the public has access) within the nominated area (lighting) for which the landlord's electrical engineer is in control of the lighting design. This would include malls, public toilets, public access passages etc.

Non Tenant Area Lighting (non-public spaces – 'back of house'): this is the lighting to all non-public common areas (to which the public does not have access) within the nominated area (lighting) for which the landlord's electrical engineer is in control of the lighting design. This would include service passages, fire escape passages, common stores, plant rooms etc.

Internal Covered Car Park Lighting: This refers to all car park lighting that is serving areas internal to the building or below the building structure (e.g. any basement parking areas or ground/above ground parking areas which are part of structured parking or beneath the building's structure). This area is equal to the summation of the 'Internal Covered Vehicle Parking Area' and the 'Sub-basement Vehicle Parking Area' as entered in the 'Building Input' sheet. All lighting that is serving parking areas with opaque 'soft' roof coverings (such as sheet metal & lightweight structure) or translucent covering (such as shade net) must be excluded from the 'Internal Covered Car Park Lighting' area, and must be included in the 'External Lighting' area defined below. Lighting within multi-story car parking buildings separate to the retail building(s), but within the same site and project scope, must also be included within 'Internal Covered Car Park Lighting'.

External Lighting: This refers to all external lighting that provides light to external areas on the site, including all lighting that is serving external parking areas with opaque 'soft' roof coverings (such as sheet metal & lightweight structure) or translucent covering (such as shade net). The area calculation must include all site area, less building footprints. The same area applies to both the notional and actual building, and thus if the actual site has less external lighting on the site than what is assumed by the calculator for the notional building site, the project is able to attain points in this way. The external lighting area must include external accessible roof areas if they are used regularly by any building occupants or building visitors for any reason (other than maintenance).

APPENDIX C

RETAIL CENTRE PROFILES

General

When calculating the energy consumption of the retail centre the following general schedule should be applied to the models:

Time	Occupancy	HVAC plant
0 to 1	0%	off
1 to 2	0%	off
2 to 3	0%	off
3 to 4	0%	off
4 to 5	0%	off
5 to 6	0%	off
6 to 7	0%	off
7 to 8	15%	off
8 to 9	60%	on
9 to 10	100%	on
10 to 11	100%	on
11 to 12	100%	on
12 to 13	100%	on
13 to 14	100%	on
14 to 15	100%	on
15 to 16	100%	on
16 to 17	100%	on
17 to 18	100%	on
18 to 19	100%	on
19 to 20	75%	on
20 to 21	50%	on
21 to 22	25%	on
22 to 23	15%	off
23 to 0	5%	off

Table 14: Retail Centre 7-day Profile

Car Parks & External Areas

When calculating the energy consumption of the ventilation in the car park area, the following profiles should be used in conjunction with the actual power requirements as per the fan specifications. (Refer to part 6 of this protocol document for other relevant details.)

Hours of the day	Plant
0 to 1	Off
1 to 2	Off
2 to 3	Off
3 to 4	Off
4 to 5	Off
5 to 6	Off
6 to 7	Off
7 to 8	On
8 to 9	On
9 to 10	On
10 to 11	On
11 to 12	On
12 to 13	On
13 to 14	On
14 to 15	On
15 to 16	On
16 to 17	On
17 to 18	On
18 to 19	On
19 to 20	On
20 to 21	On
21 to 22	On
22 to 23	Off
23 to 0	Off

Table 15: Car Parks and External Profiles for Ventilation Plant

Lighting Schedules

When modelling the notional building Schedule A for lighting should be selected. When modelling the actual building the schedule that most closely matches the actual buildings schedule must be used. Where daylight harvesting is proposed, please refer to Appendix F.

Schedule A: no or very basic controls

	Tenant areas	Non tenant area lighting (malls, public space)	Non tenant area lighting (back of house)	Car Park Lighting	External lighting
hours of day	% on	% on	% on	% on	% on
0 to 1	50%	100%	100%	100%	100%
1 to 2	50%	100%	100%	100%	100%
2 to 3	50%	100%	100%	100%	100%
3 to 4	50%	100%	100%	100%	100%
4 to 5	50%	100%	100%	100%	100%
5 to 6	50%	100%	100%	100%	100%
6 to 7	100%	100%	100%	100%	100%
7 to 8	100%	100%	100%	100%	100%
8 to 9	100%	100%	100%	100%	0%
9 to 10	100%	100%	100%	100%	0%
10 to 11	100%	100%	100%	100%	0%
11 to 12	100%	100%	100%	100%	0%
12 to 13	100%	100%	100%	100%	0%
13 to 14	100%	100%	100%	100%	0%
14 to 15	100%	100%	100%	100%	0%
15 to 16	100%	100%	100%	100%	0%
16 to 17	100%	100%	100%	100%	0%
17 to 18	100%	100%	100%	100%	0%
18 to 19	100%	100%	100%	100%	0%
19 to 20	50%	100%	100%	100%	100%
20 to 21	50%	100%	100%	100%	100%
21 to 22	50%	100%	100%	100%	100%
22 to 23	50%	100%	100%	100%	100%
23 to 0	50%	100%	100%	100%	100%
total h/day	18.5	24	24	24	13
days/week	7	7	7	7	7
total h/year	6734	8736	8736	8736	4732

Table 16: Lighting Schedule A

Schedule B: lighting controls via timers / photocells

	Tenant areas	Non tenant area lighting (malls, public space)	Non tenant area lighting (back of house)	Car Park Lighting	External lighting
hours of day	% on	% on	% on	% on	% on
0 to 1	15%	50%	25%	75%	75%
1 to 2	15%	50%	25%	50%	50%
2 to 3	15%	50%	25%	50%	50%
3 to 4	15%	50%	25%	50%	50%
4 to 5	15%	50%	25%	50%	50%
5 to 6	15%	50%	25%	50%	50%
6 to 7	15%	100%	100%	100%	100%
7 to 8	40%	100%	100%	100%	100%
8 to 9	90%	100%	100%	100%	0%
9 to 10	100%	100%	100%	100%	0%
10 to 11	100%	100%	100%	100%	0%
11 to 12	100%	100%	100%	100%	0%
12 to 13	100%	100%	100%	100%	0%
13 to 14	100%	100%	100%	100%	0%
14 to 15	100%	100%	100%	100%	0%
15 to 16	100%	100%	100%	100%	0%
16 to 17	100%	100%	100%	100%	0%
17 to 18	80%	100%	100%	100%	0%
18 to 19	60%	100%	100%	100%	0%
19 to 20	60%	50%	25%	100%	100%
20 to 21	50%	50%	25%	100%	100%
21 to 22	15%	50%	25%	100%	100%
22 to 23	15%	50%	25%	100%	100%
23 to 0	15%	50%	25%	75%	75%
total h/day	13.3	18.5	15.75	21	10
days/week	7	7	7	7	7
total h/year	4841	6734	5733	7644	3640

Table 17: Lighting Schedule B

Schedule C: lighting controls via photocells, timers, occupancy sensors & intelligent control

	Tenant areas	Non tenant area lighting (malls, public space)	Non tenant area lighting (back of house)	Car Park Lighting	External lighting
hours of day	% on	% on	% on	% on	% on
0 to 1	5%	50%	5%	25%	25%
1 to 2	5%	25%	5%	15%	10%
2 to 3	5%	25%	5%	5%	10%
3 to 4	5%	25%	5%	5%	10%
4 to 5	5%	25%	5%	5%	10%
5 to 6	5%	25%	5%	5%	10%
6 to 7	5%	25%	65%	65%	100%
7 to 8	30%	50%	85%	90%	100%
8 to 9	75%	95%	85%	90%	0%
9 to 10	100%	95%	85%	90%	0%
10 to 11	100%	95%	85%	90%	0%
11 to 12	100%	95%	85%	90%	0%
12 to 13	100%	95%	85%	90%	0%
13 to 14	100%	95%	85%	90%	0%
14 to 15	100%	95%	85%	90%	0%
15 to 16	100%	95%	85%	90%	0%
16 to 17	100%	95%	85%	90%	0%
17 to 18	100%	95%	85%	90%	0%
18 to 19	100%	95%	85%	90%	0%
19 to 20	75%	85%	15%	90%	100%
20 to 21	25%	85%	15%	90%	100%
21 to 22	15%	75%	5%	75%	100%
22 to 23	5%	75%	5%	50%	75%
23 to 0	5%	75%	5%	50%	50%
total h/day	12.65	16.9	11.6	15.6	7
days/week	7	7	7	7	7
total h/year	4604	6151	4222	5678	2548

Table 18: Lighting Schedule C

Notes

* Lights must be controlled with individual presence detectors or else in groups covering no more than 60m² 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)
Retail	0.95 for areas where hot water is provided (tenancies & common areas) or 0 for areas where no hot water is provided (tenancies & common areas)
Car Parks	0

Table 19: Benchmarks for hot water energy consumption

Protocol for calculating energy use

1. Calculate the **Daily Domestic Hot Water Requirements** 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 retail centre.** 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 20Wh / linear m of pipe should be applied.
3. Multiply the Daily Domestic Hot Water Energy Requirement by 365 days to calculate the Yearly Hot Water Energy Requirement. This number is the figure to be entered into the **Green Star SA- Retail Centre v1 Energy Calculator**.

Example (yellow section to be filled in by user)

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)
Retail Centre	0.95	2500	2375	144	52843

Table 20: Example to how to calculate hot water energy consumption

The figure to be entered into the Energy Calculator is 52843

To calculate notional building hot water energy use:

This is calculated by the Energy Calculator - the same volume of hot water is assumed to be heated electrically (efficiency 90% to allow for some distribution losses).

APPENDIX E

VERTICAL TRANSPORTATION ENERGY USE

Vertical Transportation includes lifts (elevators), escalators and travelators.

To calculate actual lift energy use:

1. Determine the lift power ratings (both service and customer lifts) in kW 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 must be done by multiplying the lift power rating by the number of lifts, then by the usage factor and finally by 12 hours per day, 365 days a year (4380 hours/year). This is the figure to be entered into the Energy Calculator.

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

LIFT POWER RATING	NUMBER OF LIFTS	USAGE FACTOR	HOURS IN A YEAR	YEARLY ENERGY USAGE (kWh/year)
25kW (passenger lift – kW rating as per supplier specifications)	2	0.75	4380	164250
30kW (service lift – kW rating as per supplier specifications)	1	0.75	4380	98550
TOTAL YEARLY ENERGY CONSUMPTION (kWh/year)				262800

Table 21: 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 of disabled lifts etc. Each lift should be assumed to have a power rating of R = 10 kW. 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 12 hours a day, 365 days a year (4380 hours/year). This number is the figure to be entered into the **Green Star SA – Retail Centre 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	4380	140160
8kW (with sensor)	2	0.75	4380	52560
TOTAL YEARLY ENERGY CONSUMPTION (kWh/year)				192720

Table 22: Example of how to calculate escalator or travelator energy consumption

To calculate notional building escalator/travelator energy use:
Assume that the notional retail centre building does not contain escalators or travelators.

APPENDIX F
DAYLIGHT DIMMING

Protocol for calculating HVAC energy and lighting energy reduction due to daylight dimming

Due to the complexity of modelling, a reduction in HVAC loads and lighting 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 of this protocol document 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*
- Number of Stories *2*
- Location *Johannesburg*
- Simulation Software Used *DesignBuilder v2*
- Weather Data Used *Meteonorm O.R.Tambo/Jan Smuts Airport 1996-2005*
- Space Breakdown

Space	Type	Included in simulation?	Area (m^2)	Comments
Mall	*Retail*	*yes*	*240*	
Tenant 1	*Retail*	*yes*	*650*	
Tenant 2	*Retail*	*yes*	*900*	
Equipment room	*Retail*	*yes*	*15*	*extract fan energy 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 have 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 Retail Centre v1 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, aluminium frame, solar coating*
Window area (m^2)	*132*	*132*
Average U value including frame and dividers	*7.9*	*2.2*
SHGF	*0.81*	*0.51*
Visual light transmittance	*0.8*	*0.7*

- 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 air changes per hour*	*0 air changes per hour*

Internal Loads

	Notional Building	**Actual Building**
Summer design temperature	*24°C*	*24°C*
Winter design temperature	*20°C*	*20°C*
Occupancy	1 person per 20m²	1 person per 20m² (even if client brief is higher/lower)
Lighting (in tenant areas)	17 W/m²	12 W/m² or as actual design (refer to lighting schedules)
Lighting (Non Tenant Area Lighting - mall & public common spaces)	12 W/m²	10 W/m² or as actual design (refer to lighting schedules)
Lighting (Non Tenant Area Lighting - non-public spaces - 'back of house')	5 W/m²	5 W/m² or as actual design (refer to lighting schedules)
Equipment loads	0 W/m²	0 W/m²
Fresh air rates	5 litres / s / person	8 litres / s / 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]