STICKMAN GROUP

GLAZING & ENERGY EFFICIENCY CONSULTANTS

OPTIMISING YOUR GREEN FUTURE

410

RATIONAL DESIGN ASSESSMENT REPORT

2018-04-06 SM18-000 WATERFALL REV 0 410-RATIONAL DESIGN REPORT

06 APR 2018

REV 0

PROJECT

SM18-000 WATERFALL

PROJECT DETAILS

ERF 0000, JUKSKEIVIEW EXT 39, JOHANNESBURG

PROJECT TEAM

PROPERTY OWNER
JOHN & JANE DOE

ARCHITECTURE FIRM
STICKMAN ARCHITECTS

COMPLIANCY AS PER

2018-04-06 SM18-000 WATERFALL - ERF 0000 REV 0 411-COMPLIANCE CERTIFICATE

UNIT

Erf 0000

THIS RATIONAL DESIGN & REPORT WAS CONDUCTED BY
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1. SANS 10400 XA COMPLIANCE METHOD

1.1 COMPLIANCE METHOD

The building located on Erf 0000, Jukskeiview Ext 39 designed by Stickman Architects has been demonstrated to comply with SANS 10400 XA by means of: Duty 21: Rational design or rational assessment of annual energy consumption to a reference building in terms of SANS 10400-XA and therefore complies with the relevant section of SANS 10400 XA as indicated below.

4.2 ENERGY USAGE AND BUILDING ENVELOPE

The functional regulations contained in part XA of the National Building Regulations shall be deemed to be satisfied where,

a) in any building of occupancy classified in terms of Regulation A20 as A1, A2, A3, A4, F1, G1, or H1, a competent person certifies that such building (excluding garage and storage areas) has a theoretical annual energy consumption and demand, based on the design assumptions contained in 4.3, less than or equal to the values specified in tables 2 and 3; or

b) in any building of occupancy classified in terms of Regulation A20 as A1, A2, A3, A4, C1, C2, E1, E2, E3, E4, F1, F2, F3, G1, H1, H2, H3, H4, and H5, the orientation and shading are in accordance with the requirements of SANS 204, external walls are in accordance with the requirements of 4.4.3, fenestration is in accordance with the requirements of 4.4.4, roof assembly construction is in accordance with the requirements of 4.4.5, if in-slab heating is installed, it is in accordance with the requirements of 4.4.2, and services that use energy or control the use of energy, including heating, air conditioning and mechanical ventilation in accordance with SANS 204, and hot water systems in accordance with the requirements of 4.1 (services exclude cooking

c) in any building of occupancy classified in terms of Regulation A20 as A1, A2, A3, A4, C1, C2, E1, E2, E3, E4, F1, F2, F3, G1, H1, H2, H3, H4, and H5, a competent person certifies that such building (excluding garage and storage areas) has a theoretical annual energy consumption and demand less than or equal to a reference building that complies with the requirements of 4.2.1(b).

REFERENCE: SANS 10400-XA:2011. pg 6-7.

This report details the method, simulated loads, environmental conditions and make up of the simulated actual building and additionally, in the case of 4.2.c) above, the reference building.

1.2 SIMULATION METHODOLOGY

The building is built in DesignBuilder complete with all material properties and energy loads. A reference building matching the actual in massed form is built using material properties and loading as compliant with SANS 10400-XA, 4.2. b) indicated above. The two buildings undergo a 12 month simulation simulated at hourly intervals. The total energy peak demand and consumption are then compared.

2. SIMULATION SOFTWARE

3.3 CERTIFIED THERMAL CALCULATION SOFTWARE

Software that is certified by the Board of Agrément South Africa, in terms of Agrément South Africa's Energy Software Protocols, as being fit for thermal modelling or calculation purposes in terms of the National Building Regulations.

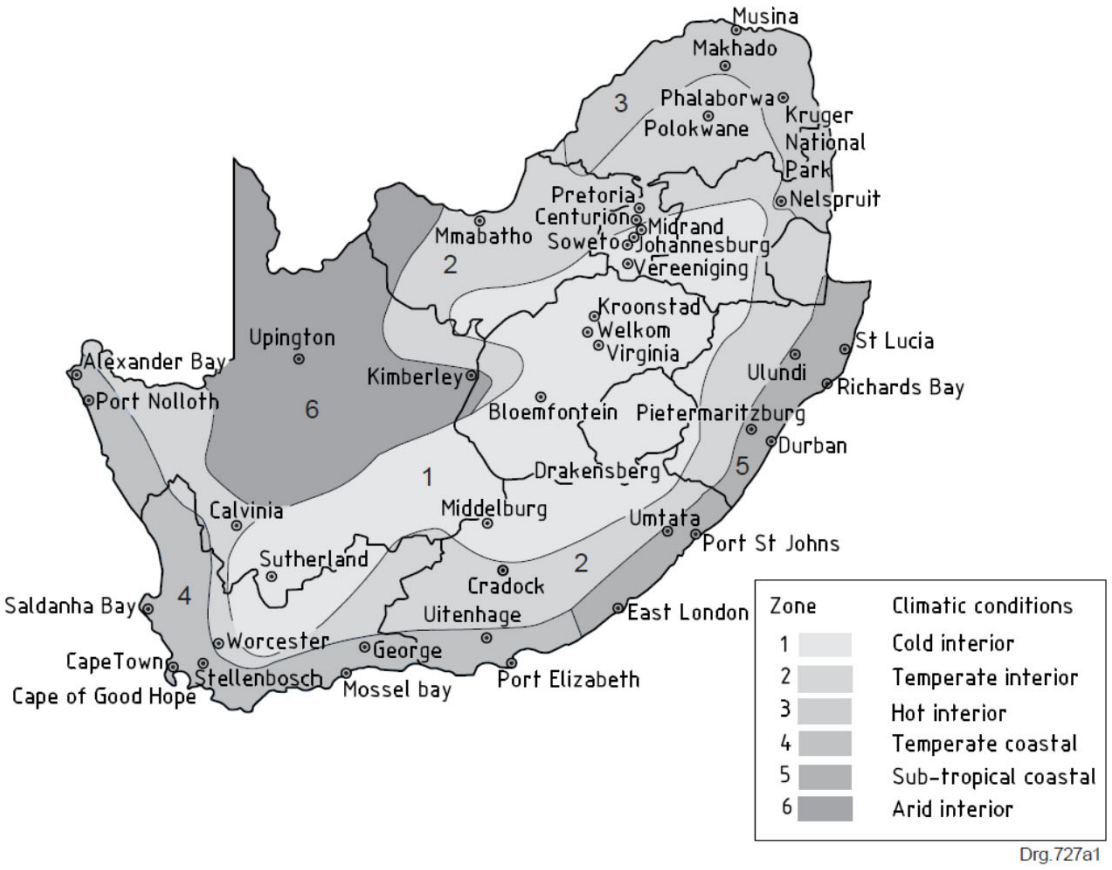
REFERENCE: SANS 10400-XA:2011. P 4.

DesignBuilder 4.0 has been certified in terms of Agrément South Africa's Energy Software Protocols and is therefore suitable to perform all required simulations and is in accordance with requirements of SANS 10400-XA regarding certified thermal software.

3. SIMULATION DETAILS

3.1. CLIMATE ZONE AND OCCUPANCY

SANS 204 divides South Africa into 6 climate zones as indicated in the diagram and table below.



Zone	Description	Major Centre
1	Cold interior	Johannesburg, Bloemfontein
2	Temperate interior	Pretoria, Polokwane
3	Hot interior	Makhado, Nelspruit
4	Temperate coastal	Cape Town, Port Elizabeth
5	Sub-tropical coastal	East London, Durban, Richards Bay
6	Arid interior	Upington, Kimberley

REFERENCE: SANS 204:2011. Annex A.

The climate zone dictates the minimum requirements for many aspects of the building's fabric and the weather data used for simulation.

CLIMATE ZONE	LOCATION	WEATHER DATA USED
1	Johannesburg	ZA_Climate_Zone_1:_Johannesburg.epw

The occupancy affects many aspects of the building's internal loading, population and in some cases assembly requirements.

OCCUPANCY CLASS

H4 - Dwelling House

This results in the following requirements used within the reference building.

ASSEMBLY REQUIREMENTS

ORIENTATION

The reference building has been orientated to best meet the guidelines stated in SANS 10400-XA 4.4.1. indicated below:

- "Rooms that are used most and the major areas of glazing placed on the northern side of the building"
- "Living spaces should be arranged so that the rooms where people spend most of their hours are located on the northern side of the unit."
- "Uninhabited rooms, such as bathrooms and storerooms, can be used to screen unwanted western sun or to prevent heat loss on the south-facing facades."
- "The longer axis of the dwelling should be orientated so that it runs as near east/west as possible."
- "Windows facing east and west should be limited in number and confined to the minimum required for daylight and ventilation."

FLOORS

No underfloor heating therefore no minimum requirements as per SANS 10400-XA, 4.4.2.

EXTERNAL WALLS

R = 0.35 (as per SANS 10400-XA, 4.4.3.2 - 4.4.3.3)

ROOF

R = 3.7 and Direction of Heat Flow = Up (as per SANS 10400-XA, 4.4.5.)

FENESTRATION

FOR NATURALLY VENTILATED STRUCTURES:

$\Sigma [Un \times An] \leq 1.2 \times$ Net int Flr Area per storey and
$\Sigma [An \times Sn \times En] \leq 0.15 \times$ Net int Flr Area per storey.
En as per SANS 204, Annex C. (as per SANS 204, as referenced in SANS 10400-XA, 4.4.4.2.)

FOR ARTIFICIALLY VENTILATED STRUCTURES:

$\Sigma[An(Sn(CA \times SHn + CB \times SCn) + CC \times Un)] \leq 0.22 \times$ façade area per floor.
SHn, SCn, CA, CB, CC as per SANS 204, Annex D. (as per SANS 204, as referenced in SANS 10400-XA, 4.4.4.2.)

POPULATION VALUES

POPULATION

2 persons per bedroom therefore 8 (As per SANS 10400:A A21.2)

OCCUPANCY TIMES

24/7 with variable use on loading to meet loading requirements.

INTERNAL LOADING VALUES

LIGHTING LOADS

MAX LIGHTING DEMAND
H4 - Dwelling House therefore = 5W/m² (As per SANS 204 4.5.1.3.)

MAX LIGHTING CONSUMPTION
H4 - Dwelling House therefore = 5kWh/m² (As per SANS 204 4.5.1.3.)

HOT WATER HEATING

HOT WATER ENERGY REQUIREMENTS
A minimum of 50% by volume of the annual average hot water heating requirement shall be provided by means other than electrical resistance heating. (As per SANS 204 4.5.2.1.)

TOTAL HOT WATER DEMAND
High End Dwelling House therefore 140L / capita / day
(As per SANS 10252-1 4.2.3.2.)

HOT WATER STORAGE VOLUME
High End Dwelling House therefore 50L / capita
(As per SANS 10252-1 4.2.3.2.)

HOT WATER HEATER POWER
High End Dwelling House therefore 5kW / Unit
(As per SANS 10252-1 4.2.3.2.)

MIN. PERFORM. OF NON-RESISTANCE HOT WATER HEATING
Minimum COP = 2.5
(As per SANS 204 4.6.9.)

GENERAL INTERNAL LOADS

SENSIBLE HEAT GAINS FROM POPULATION
75W per person. (As per SANS 10400 XA recommended assumptions 4.3.4.i.)

GAINS FROM HOT MEALS
30W per person. (As per SANS 10400 XA recommended assumptions 4.3.4.ii.)

HEAT GAINS FROM APPLIANCES AND EQUIPMENT
None. (As per SANS 10400 XA recommended assumptions 4.3.4.iii.)

INTERNAL COMFORT DESIGN TEMPERATURES

MINIMUM
19°C (As per SANS 10400 XA recommended assumptions 4.3.2.)

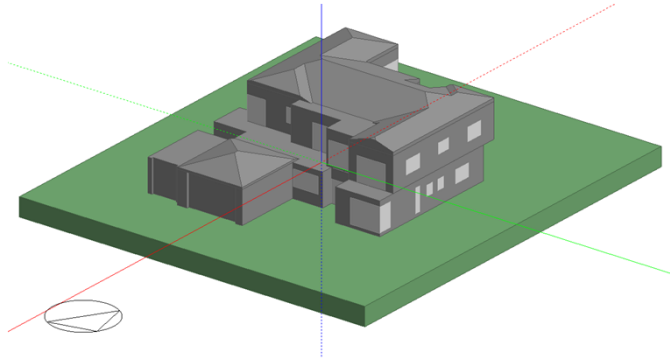
MAXIMUM
25°C (As per SANS 10400 XA recommended assumptions 4.3.2.)

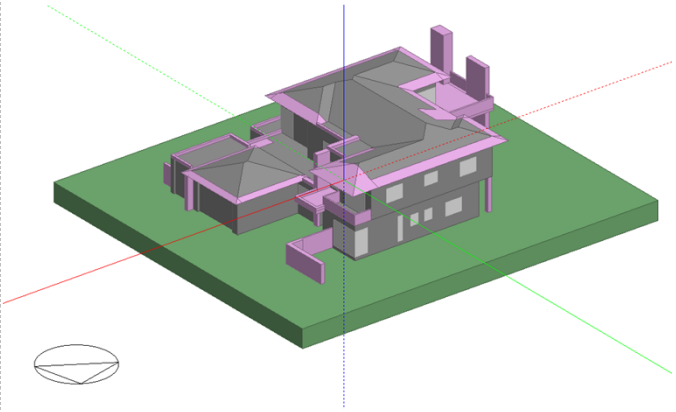
3.2. BUILDING GEOMETRY

The following building geometry was created based on the drawings provided by the architect. The reference building has been built using an identical footprint and opening, but, as is apparent, all shading devices and overhangs have been excluded.

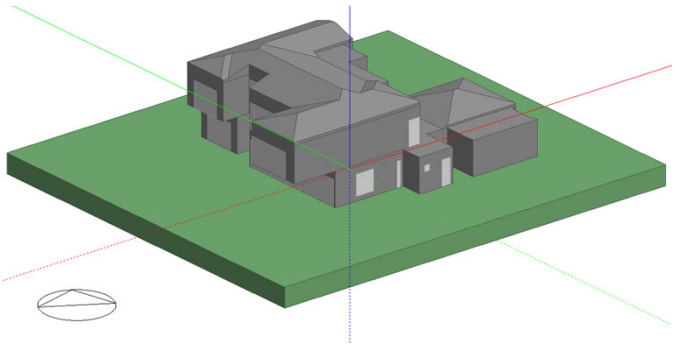
REFERENCE BUILDING	ACTUAL BUILDING

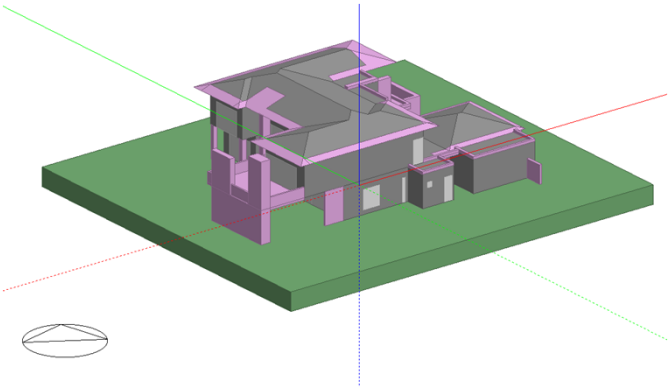
NORTH FACE





SOUTH FACE





3.3. ORIENTATION

As per the requirements stated in 3.1, the reference building was modelled up with the following orientation.

	REFERENCE BUILDING	ACTUAL BUILDING
ANGLE OF NORTH (with relation to vertical axis on provided plans)	58°	58°

3.4. FLOOR ASSEMBLY

As per the minimum requirements stated in 3.1, the building was modelled up with the following values. Each structure has been described from exterior to interior. All Thermal conductivity values have been taken from SANS 10456:2007 where unavailable from manufacturer. All surface coefficient values have been calculated in accordance with SANS 6946:1996. R-Values achieved by reflective foil laminates as per SANS 204:2011.

3.4.1. REFERENCE BUILDING

3.4.1.1. GROUND FLOOR SURFACE BED

MATERIAL	THICKNESS (m)	CONDUCTIVITY (W/m.K)	R VALUE (m².K/W)
High Density Concrete	0.085	2.000	0.043
Screed	0.040	1.000	0.040
Horizontal Internal Surface Coefficient (Floor)	N/A	N/A	0.110
		TOTAL R VALUE =	0.193
		SANS 10400-XA MINIMUM REQUIRED R VALUE =	None

FULL DESCRIPTION

85mm High Density Concrete, with 40mm Screed over.

3.4.2. ACTUAL BUILDING

3.4.2.1. GROUND FLOOR SURFACE BED

MATERIAL	THICKNESS (m)	CONDUCTIVITY (W/m.K)	R VALUE (m².K/W)
Waterproofing Membrane	0.001	0.170	0.006
Medium Density Concrete	0.085	1.150	0.074
Screed	0.040	1.000	0.040
Ceramic tiles	0.010	1.300	0.008
Horizontal Internal Surface Coefficient (Floor)	N/A	N/A	0.110
		TOTAL R VALUE =	0.237

FULL DESCRIPTION

Waterproofing Membrane, with 85mm Medium Density Concrete over, with 40mm Screed over, with 10mm Ceramic tiles over.

3.5. WALL ASSEMBLY

As per the minimum requirements stated in 3.1, the building was modelled up with the following values. Each assembly has been described from exterior to interior. All Thermal conductivity values have been taken from SANS 10456:2007 where unavailable from manufacturer. All surface coefficient values have been calculated in accordance with SANS 6946:1996. R-Values achieved by reflective foil laminates as per SANS 204:2011.

3.5.1. REFERENCE BUILDING

3.5.1.1. EXTERNAL WALL

MATERIAL	THICKNESS (m)	CONDUCTIVITY (W/m.K)	R VALUE (m².K/W)
3m/s Wind External Surface Coefficient	N/A	N/A	0.040
Low Grade Masonry Brick	0.230	1.200	0.192
Vertical Internal Surface Coefficient	N/A	N/A	0.120
		TOTAL R VALUE =	0.352
		SANS 10400-XA MINIMUM REQUIRED R VALUE =	0.350

FULL DESCRIPTION

Wall structure comprised of 230mm Low Grade Masonry Brick.

3.5.2. ACTUAL BUILDING

3.5.2.1. EXTERNAL WALL

MATERIAL	THICKNESS (m)	CONDUCTIVITY (W/m.K)	R VALUE (m².K/W)
3m/s Wind External Surface Coefficient	N/A	N/A	0.040
Cement Plaster	0.012	1.000	0.012
Clay fired brick (as derived from Corobrik unit analysis)	0.230	0.470	0.489
Cement Plaster	0.012	1.000	0.012
Vertical Internal Surface Coefficient	N/A	N/A	0.120
		Total R Value =	0.673

FULL DESCRIPTION

Wall structure comprised of 12mm Cement Plaster, 230mm Clay fired brick (as derived from Corobrik unit analysis), and 12mm Cement Plaster.

3.6. ROOF ASSEMBLY

As per the minimum requirements stated in 3.1, the building was modelled up with the following values. Each structure has been described from exterior to interior. All Thermal conductivity values have been taken from SANS 10456:2007 where unavailable from manufacturer. All surface coefficient values have been calculated in accordance with SANS 6946:1996. R-Values achieved by reflective foil laminates as per SANS 204:2011.

3.6.1. REFERENCE BUILDING

3.6.1.1. PITCHED ROOF STRUCTURE

MATERIAL	THICKNESS (m)	CONDUCTIVITY (W/m.K)	R VALUE (m².K/W)
3m/s Wind External Surface Coefficient	N/A	N/A	0.040
Steel Roof Sheeting	0.001	45.000	0.000
Pitched Non-Reflective unventilated Air Space (Heat flow upwards)	0.100	N/A	0.180
Flexible Fibreglass blanket	0.133	0.040	3.333
Gypsum Plasterboard	0.009	0.210	0.043
Horizontal Internal Surface Coefficient (Heat flow upwards)	N/A	N/A	0.110
		Total R Value =	3.705
		SANS 10400-XA Minimum required R Value =	3.700

FULL DESCRIPTION

Steel Roof Sheeting, with 100mm Pitched Non-Reflective unventilated Air Space (Heat flow upwards) below, with 133.3mm Flexible Fibreglass blanket below, with 9mm Gypsum Plasterboard below.

3.6.2. ACTUAL BUILDING

3.6.2.1. PITCHED ROOF STRUCTURE

MATERIAL	THICKNESS (m)	CONDUCTIVITY (W/m.K)	R VALUE (m².K/W)
3m/s Wind External Surface Coefficient	N/A	N/A	0.040
Steel Roof Sheeting	0.001	45.000	0.000
Pitched Non-Reflective unventilated Air Space (Heat flow upwards)	0.100	N/A	0.180
Flexible Fibreglass blanket	0.135	0.040	3.375
Gypsum Plasterboard	0.012	0.210	0.057
Horizontal Internal Surface Coefficient (Heat flow upwards)	N/A	N/A	0.110
		Total R Value =	3.762

FULL DESCRIPTION

Steel Roof Sheeting, with 100mm Pitched Non-Reflective unventilated Air Space (Heat flow upwards) below, with 135mm Flexible Fibreglass blanket below, with 12mm Gypsum Plasterboard below.

3.7. FENESTRATION

As per the minimum requirements stated in 3.1, the building was modelled up with the following values. The glazing in the reference building has been assigned a theoretical value to meet the minimum requirements and is not representative of any specific product or frame type. Storeys have been grouped together as subdividing would result in negligible difference due to whole building analysis.

3.7.1. REFERENCE BUILDING

The U value and SHGC value stipulated below is the value for the whole glazed assembly and not a Ug or SHGCg (centre of glass value).

TOTAL GLAZED AREA (only glazing relevant to thermal zones)					154.0 m²
CLIMATE ZONE	MAXIMUM C_U	REQ. U VALUE	APPROX. INT FLOOR AREA	MAX C_{SHGC}	REQ. SHGC VALUE
1 - Cold interior	0	2.98	383.0 m²	57.45	0.39

3.7.2. ACTUAL BUILDING

The glazing and frame combination specified below is as per values from SANS204 and any glazing and frame combination that is equal or greater in performance may be used.

TOTAL GLAZED AREA (only glazing relevant to thermal zones)	154.0 m²
CLIMATE ZONE	GLAZING CONFIGURATION
1 - Cold interior	Single Clear Glazing in an Aluminium Frame or better product

3.8. INTERNAL LOADS

As per the minimum requirements stated in 3.1, the building was modelled up with the following values. Hot water loading has been calculated in accordance with SANS 10252-1.

3.8.1. REFERENCE BUILDING

LIGHTING LOADS

LIGHTING ELECTRICAL DEMAND	LIGHTING ELECTRICAL CONSUMPTION
5.00 W/m²	5.00 kWh/m²

HOT WATER HEATING

HOT WATER SYSTEM	ENERGY DEMAND	ENERGY CONSUMPTION
50% Electrical Resistance & 50% 2.5 COP Heat Pump	7.00 kW/month	3.58 kWh/month

3.8.2. ACTUAL BUILDING

LIGHTING LOADS

LIGHTING ELECTRICAL DEMAND	LIGHTING ELECTRICAL CONSUMPTION
5.00 W/m²	5.00 kWh/m²

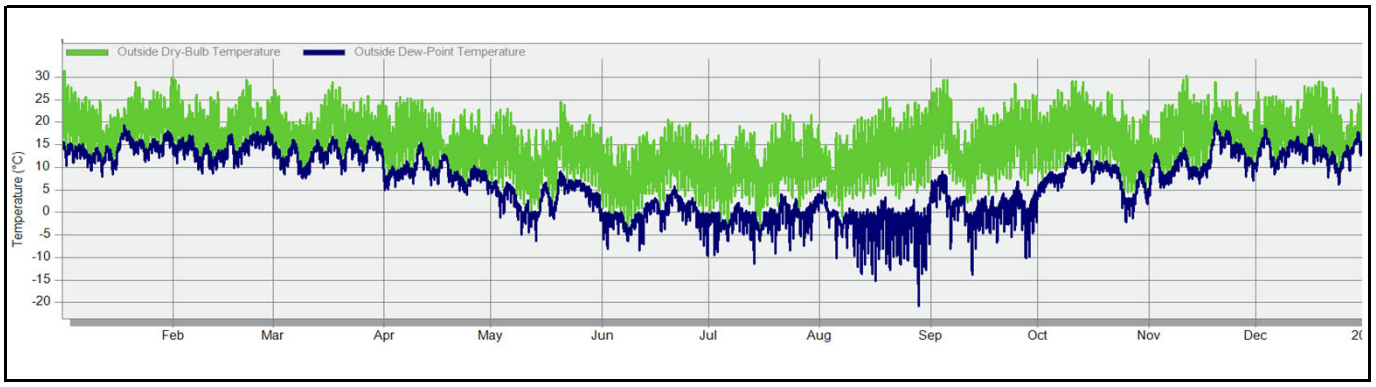
HOT WATER HEATING

HOT WATER SYSTEM	ENERGY DEMAND	ENERGY CONSUMPTION
50% Electrical Resistance & 50% 2.5 COP Heat Pump or Better	7.00 kW/month	3.58 kWh/month

4. SIMULATION RESULTS

4.1. CLIMATE CONDITIONS

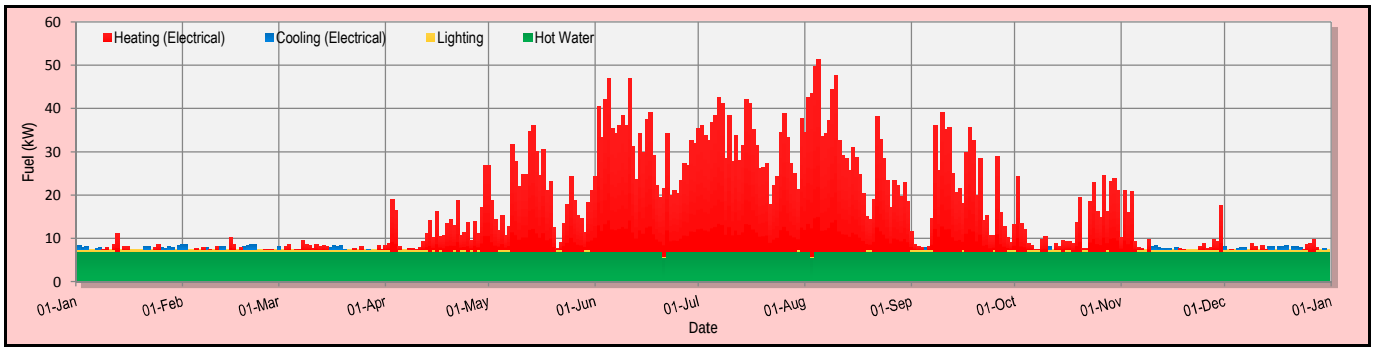
The following graph demonstrates the dew point temperature and dry bulb temperatures for the duration of the simulation.



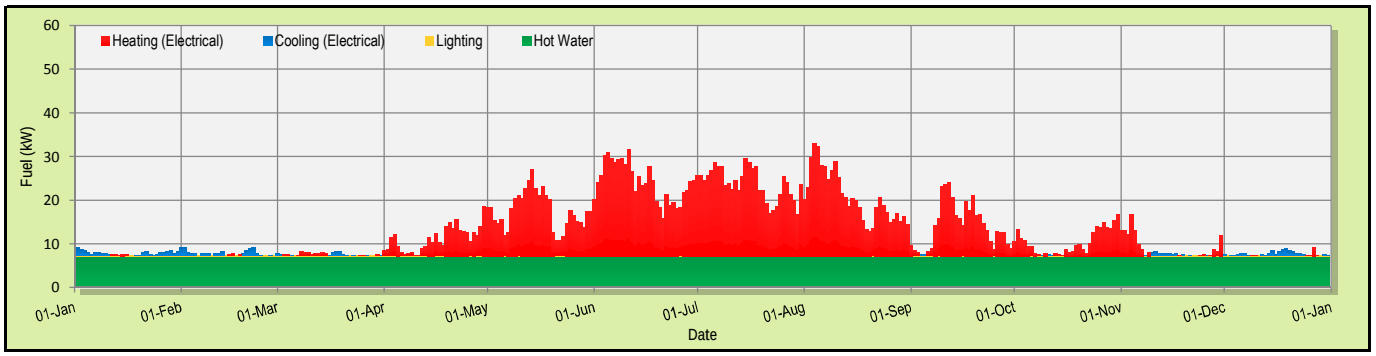
4.2. ANNUAL ENERGY DEMAND

The following graphs depicts the peak energy demand per day required to maintain the building within the design temperature based on climate impact and all internal loading and calculated hourly.

4.2.1. REFERENCE BUILDING



4.2.2. ACTUAL BUILDING



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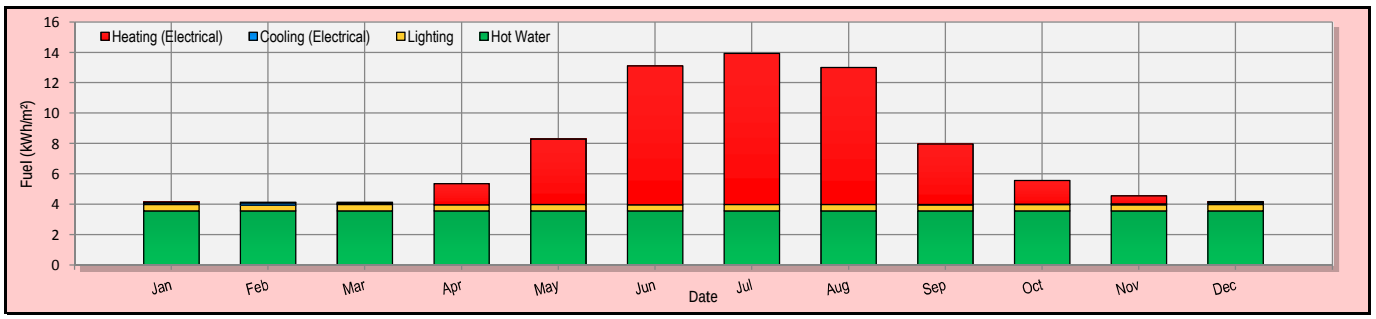
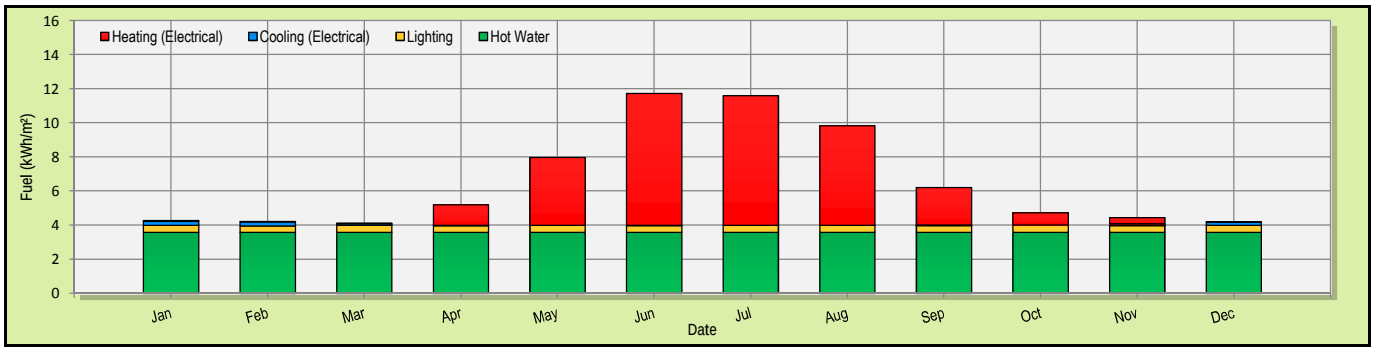
4.3. ANNUAL ENERGY CONSUMPTION

The following graphs depicts the energy consumption required to maintain the building within the design temperature based on climate impact and all internal loading.

4.3.1. REFERENCE BUILDING



4.3.2. ACTUAL BUILDING



4.4. FINAL COMPARISON

Here follows the average energy demand and total energy consumption the actual building utilises and compares this to that used by the reference building as outlined in the corresponding project rational design certificate.

AVG PEAK ENERGY DEMAND

REFERENCE BUILDING
79.61 VA / m² (100%)

COMPLIANT

ACTUAL BUILDING
56.37 VA / m² (70.81%) - COMPLIANT

TOTAL ENERGY CONSUMPTION

REFERENCE BUILDING
88.57 kWh / m² / annum (100%)

COMPLIANT

ACTUAL BUILDING
78.53 kWh / m² / annum (88.67%) - COMPLIANT

	REFERENCE BUILDING	ACTUAL BUILDING	% OF REFERENCE
AVG PEAK ENERGY DEMAND	79.61 VA / m²	56.37 VA / m²	70.81%
TOTAL ENERGY CONSUMPTION	88.57 kWh / m² / annum	78.53 kWh / m² / annum	88.67%

COMPLIANCE SUMMARY

The actual building has a theoretical energy demand and consumption lower than that of the reference building and therefore, this building complies with the requirements of SANS 10400-XA.

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