STICKMAN GROUP

GLAZING & ENERGY EFFICIENCY CONSULTANTS

OPTIMISING YOUR GREEN FUTURE

470 ENERGY STUDIES REPORT

2019-11-18 SM19-014 - House Van Staden Rev 0 470-Energy Studies Report

18 NOV 2019

REV 0

PROJECT

SM19-014 - HOUSE VAN STADEN

PROJECT DETAILS

ERF 37, RIETVLEI, PRETORIA

PROJECT TEAM

PROPERTY OWNER

JOHAN VAN STADEN

ARCHITECTURE FIRM

URBAN CONCEPT ARCHITECTS

THIS ENERGY STUDIES REPORT WAS CONDUCTED BY

ADAM SWARTZ

2. FINAL RESULTS & RECOMMENDATIONS

2.1. FINAL RESULTS: ENERGY PERFORMANCE

The following table illustrates the top results in terms of performance of the total annual energy consumption from the lowest to highest:

		TOTAL ANNUAL ENERGY CONSUMPTION (ELECTRICITY)			
		HEATING	COOLING	TOTAL	Δ %
1	Top Sim 1	6718 kWh	259 kWh	**6976 kWh**	
2	Wall 3 Simulation	7677 kWh	454 kWh	**8131 kWh**	16.55%
3	Double Low-E Clear Throughout	8609 kWh	231 kWh	**8840 kWh**	22.92%
4	Top sim 2 with insulation under slab	6662 kWh	2183 kWh	8844 kWh	21.13%
5	Mix 7	8765 kWh	265 kWh	9030 kWh	23.22%
6	Original Building Design (Steel Roof Structure)	12427 kWh	591 kWh	13018 kWh	66.91%

2.2. TOP PERFORMERS RECOMMENDATIONS

Below is the recommended construction to achieve high energy efficiency based on the below construction materials:

FOR OPTIMUM ENERGY EFFICIENCY:

Top Sim 1

FOR ENERGY EFFICIENCYAT A LOWER CONSTRUCTION COST THAN OPTIMUM:

Wall 3 Simulation OR Double Low-E Clear Throughout

2.3. TOP PERFORMERS ENERGY CONSUPTION PER SEASON

SEASON	MONTH	Double Low-E Clear Throughout		Wall 3 Simulation		Top Sim 1	
		Heating (kWh)	Cooling (kWh)	Heating (kWh)	Cooling (kWh)	Heating (kWh)	Cooling (kWh)
SUMMER	DECEMBER	0.00	37.52	0.00	78.90	0.00	42.29
	JANUARY	0.00	83.17	0.00	144.62	0.00	91.84
	FEBRUARY	0.00	77.14	0.00	129.87	0.00	84.26
	SUMMER TOTALS	**0.00**	**197.83**	**0.00**	**353.39**	**0.00**	**218.39**
AUTUMN	MARCH	0.03	21.01	0.00	49.99	0.00	26.02
	APRIL	115.88	0.02	109.26	2.87	54.88	0.24
	MAY	867.45	0.21	750.07	5.63	605.53	1.05
	AUTUMN TOTALS	**983.35**	**21.23**	**859.32**	**58.49**	**660.41**	**27.31**
WINTER	JUNE	2 270.21	0.00	1 999.24	0.87	1 740.38	0.01
	JULY	2 608.84	0.00	2 318.57	0.01	2 071.85	0.00
	AUGUST	1 962.89	0.00	1 774.16	0.14	1 636.40	0.00
	WINTER TOTALS	**6 841.94**	**0.00**	**6 091.96**	**1.02**	**5 448.62**	**0.01**
SPRING	SEPTEMBER	596.20	0.00	550.24	1.10	483.09	0.00
	OCTOBER	154.45	3.08	141.87	12.22	107.00	2.83
	NOVEMBER	32.97	9.04	33.79	27.70	18.59	10.11
	SPRING TOTALS	**783.62**	**12.11**	**725.89**	**41.02**	**608.68**	**12.94**

BUILDING MATERIAL RECOMMENDATIONS

2.4. RECOMMENDED CONSTRUCTION MATERIAL SPECIFICATIONS

Below is the specifications of construction materials that are recommended based on the final results of the analysis

KEY: ✔ Highly Recommended 📌 Recommended minimum to be used

2.4.1. SPECIFICATIONS PER SIMULATION

	EXTERNAL WALL TYPES	SPECIFICATIONS
📌	WALL 2: 280MM CAVITY WALL	2 x 115mm brick with 50mm air cavity and 12mm plaster on each side
✔	WALL 3: 280MM INSULATED WALL	2 x 115mm brick with 50mm insulated cavity and 12mm plaster on each side

2.4.2. INTERNAL WALL SPECIFICATIONS

	TYPE	SPECIFICATIONS
📌	INTERNAL WALLS	1 x 115mm Brick with 12mm plaster on each side

2.4.3. ROOF SPECIFICATIONS

FLAT ROOF 1	Architect's Specification: 40mm Gravel, **[XX]**mm XPS, 4mm Bitumen, 40mm Screed, 170mm Concrete
FLAT ROOF 2	
PITCHED ROOF 1	Architect's Specification: 0.5mm Sheeting, (0.01mm Sisalation), **(YY)**mm Airspace, **{ZZ}**mm Fibre glass insulation, 6mm Ceiling board
PITCHED ROOF 2	

	TYPE	FLAT ROOF 1	FLAT ROOF 2	PITCHED ROOF 1	PITCHED ROOF 2
📌	ROOF 2	**[40]**		**(600) {100}**	
✔	ROOF 3	**[50]**		**(600) {135}**	

2.4.4. EXTERNAL GLASS SPECIFICATIONS

	TYPE	LOW PRIORITY	MEDUIM PRIORITY	HIGH PRIORITY	ROOF / SKY LIGHTS
Alternative	GLASS 4	Double Clear	Double Clear	Double Clear	
✔	GLASS 5	Double Low-E Clear	Double Low-E Clear	Double Low-E Clear	
📌	MIX 7	Single Low-E Clear	Double Clear	Double Low-E Clear	

2.4.5. FLOOR SPECIFICATIONS

	TYPE	SPECIFICATIONS	INSULATION
📌	GROUND FLOOR	As per Architect's Specification: 85mm Concrete, 25mm Screed, 10mm Tiles	**NO**

3. SIMULATION SOFTWARE

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.

3.1. SIMULATION DETAILS

3.1.1 CLIMATE ZONE AND OCCUPANCY

CLIMATE ZONE	LOCATION	WEATHER DATA USED
2	Pretoria	ZA_Climate_Zone_2:_Pretoria.epw

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

OCCUPANCY CLASS

H4 - Dwelling House

3.1.2 POPULATION VALUES

POPULATION

2 persons per bedroom therefore 4 (As per SANS 10400:A A21.2)

OCCUPANCY TIMES

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

3.1.3 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.)

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

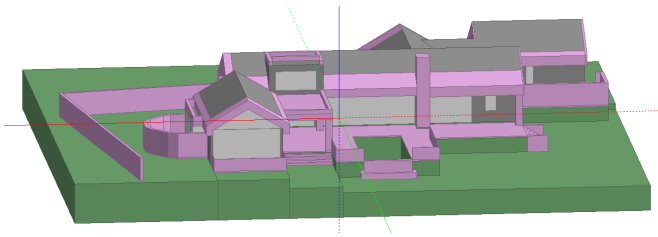
MINIMUM
19°C (As per SANS 10400 XA recommended assumptions 4.3.2.)

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

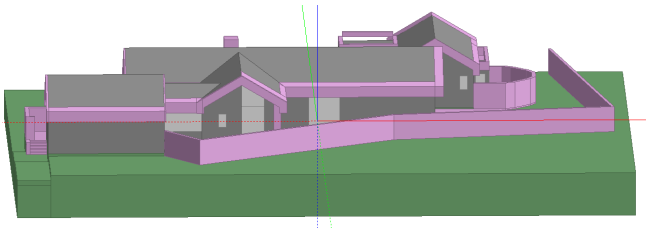
4. BUILDING DESIGN IMAGES

The following building geometry was created based on the drawings provided by the architect.

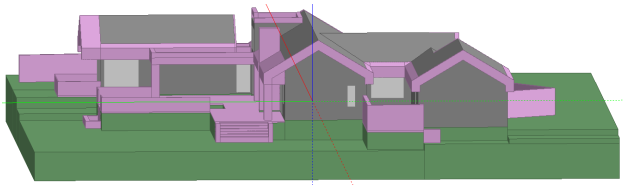
NORTH ELEVATION



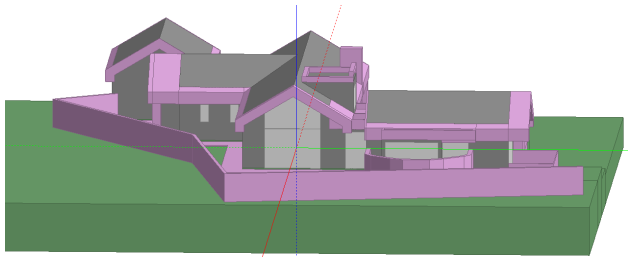
SOUTH ELEVATION



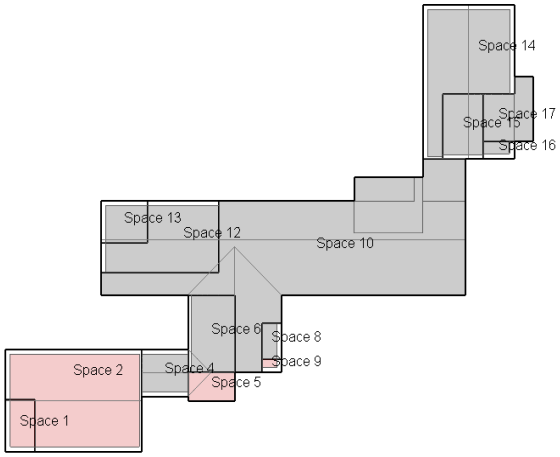
EAST ELEVATION

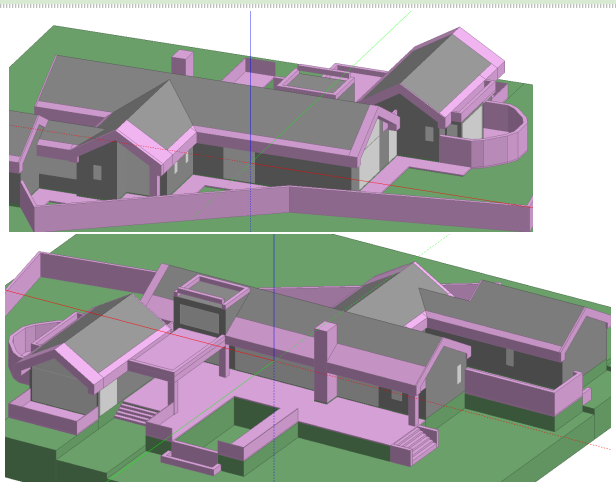


WEST ELEVATION



INTERIOR AND CLOSEUP VIEWS





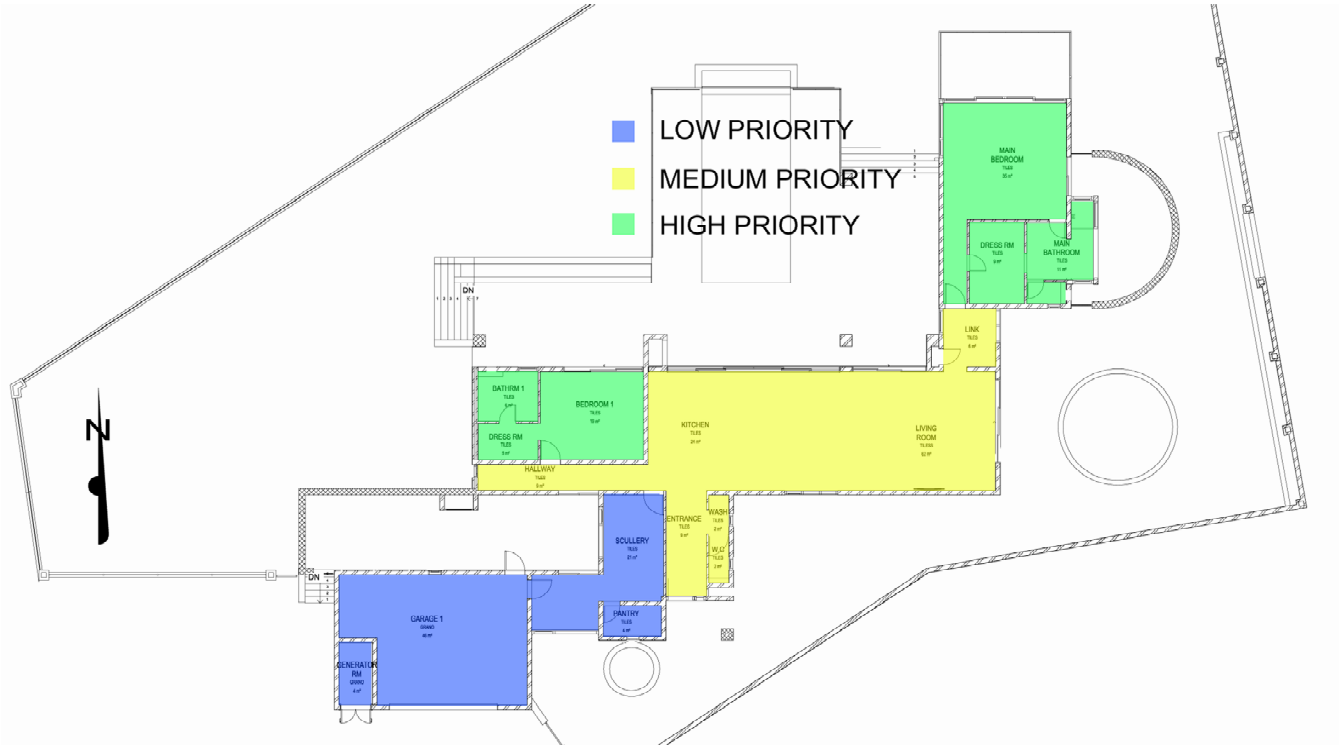
4.1. ORIENTATION

The building was modelled up with the following orientation.

ANGLE OF NORTH (with relation to vertical axis on provided plans) **0°**

4.2. PRIORITY ZONES: GLASS ALLOCATION

Below you will find the glass allocation defined by zones in terms priority
The higher the priority the higher the need for thermal comfort and therfore higher specification glass would be used in higher priority zones.



4.2.1. GLASS ALLOCATION IN SIMULATIONS:

Below is a list of glass products that were specified in each priority zone and simulated.

TYPE	LOW PRIORITY	MEDUIM PRIORITY	HIGH PRIORITY	ROOF / SKY LIGHTS
GLASS 1	Single Clear	Single Clear	Single Clear	
GLASS 2	Single Low-E Clear	Single Low-E Clear	Single Low-E Clear	
GLASS 3	Single Low-E Tint	Single Low-E Tint	Single Low-E Tint	
GLASS 4	Double Clear	Double Clear	Double Clear	
GLASS 5	Double Low-E Clear	Double Low-E Clear	Double Low-E Clear	
GLASS 6	Double Low-E Tint	Double Low-E Tint	Double Low-E Tint	
MIX 7	Single Low-E Clear	Double Clear	Double Low-E Clear	
MIX 8	Single Low-E Clear	Double Clear	Double Clear	
MIX 9	Single Low-E Clear	Single Low-E Clear	Double Clear	
	Single Clear	Single Low-E Clear	Double Clear	

5. WALL SIMULATIONS

5.1. WALL RESULTS: ENERGY PERFORMANCE

The following table illustrates the top 3 results in terms of performance of the total annual energy consumption from the lowest to highest:

		TOTAL ANNUAL ENERGY CONSUMPTION (ELECTRICITY)			
		HEATING	COOLING	TOTAL	Δ %
1	WALL 3: 280MM INSULATED WALL	7677 kWh	454 kWh	**8131 kWh**	
2	WALL 2: 280MM CAVITY WALL	9560 kWh	402 kWh	**9962 kWh**	22.52%
3	WALL 1: 230MM BRICK WALL	10491 kWh	381 kWh	**10873 kWh**	27.52%
4					
5					
6					

5.2. WALL RECOMMENDATIONS

Below is the recommended construction to achieve high energy efficiency based on the below construction materials:

FOR OPTIMUM ENERGY EFFICIENCY:

WALL 3: 280MM INSULATED WALL 2 x 115mm brick with 50mm insulated cavity and 12mm plaster on each side

FOR ENERGY EFFICIENCYAT A LOWER CONSTRUCTION COST THAN OPTIMUM:

WALL 2: 280MM CAVITY WALL 2 x 115mm brick with 50mm air cavity and 12mm plaster on each side

5.3. WALL ENERGY CONSUPTION PER SEASON

SEASON	MONTH	WALL 1: 230MM BRICK WALL		WALL 2: 280MM CAVITY WALL		WALL 3: 280MM INSULATED WALL	
		Heating (kWh)	Cooling (kWh)	Heating (kWh)	Cooling (kWh)	Heating (kWh)	Cooling (kWh)
SUMMER	DECEMBER	0.82	67.87	0.30	71.07	0.00	78.90
	JANUARY	0.00	122.97	0.00	129.36	0.00	144.62
	FEBRUARY	0.00	111.55	0.00	116.91	0.00	129.87
	SUMMER TOTALS	**0.82**	**302.39**	**0.30**	**317.34**	**0.00**	**353.39**
AUTUMN	MARCH	1.69	38.92	0.74	42.08	0.00	49.99
	APRIL	223.84	0.90	181.81	1.27	109.26	2.87
	MAY	1 144.96	2.80	1 012.42	3.56	750.07	5.63
	AUTUMN TOTALS	**1 370.48**	**42.61**	**1 194.97**	**46.91**	**859.32**	**58.49**
WINTER	JUNE	2 779.62	0.09	2 521.42	0.17	1 999.24	0.87
	JULY	3 098.87	0.00	2 844.23	0.00	2 318.57	0.01
	AUGUST	2 244.64	0.04	2 093.39	0.07	1 774.16	0.14
	WINTER TOTALS	**8 123.13**	**0.12**	**7 459.04**	**0.23**	**6 091.96**	**1.02**
SPRING	SEPTEMBER	719.21	0.95	663.29	1.01	550.24	1.10
	OCTOBER	217.01	11.93	191.27	12.03	141.87	12.22
	NOVEMBER	60.78	23.51	51.22	24.68	33.79	27.70
	SPRING TOTALS	**996.99**	**36.38**	**905.78**	**37.72**	**725.89**	**41.02**

WALL SIMULATION INFORMATION:

5.4. CONSTRUCTION MATERIAL SPECIFICATIONS

Below is the specifications of construction materials used in the simulations that have determined the above performance results.

KEY: Material being investigated in simulations | Constant material used in each simulation

5.4.1. SPECIFICATIONS PER SIMULATION

	EXTERNAL WALL TYPES	SPECIFICATIONS
	WALL 1: 230MM BRICK WALL	2 x 115mm brick with 12mm plaster on each side
	WALL 2: 280MM CAVITY WALL	2 x 115mm brick with 50mm air cavity and 12mm plaster on each side
	WALL 3: 280MM INSULATED WALL	2 x 115mm brick with 50mm insulated cavity and 12mm plaster on each side

5.4.2. INTERNAL WALL SPECIFICATIONS

	TYPE	SPECIFICATIONS
	INTERNAL WALLS	1 x 115mm Brick with 12mm plaster on each side

5.4.3. ROOF SPECIFICATIONS

FLAT ROOF 1 — Architect's Specification: 40mm Gravel, **[XX]**mm XPS, 4mm Bitumen, 40mm Screed, 170mm Concrete

FLAT ROOF 2

PITCHED ROOF 1 — Architect's Specification: 0.5mm Sheeting, (0.01mm Sisalation), **(YY)**mm Airspace, **{ZZ}**mm Fibre glass insulation, 6mm Ceiling board

PITCHED ROOF 2

TYPE	FLAT ROOF 1	FLAT ROOF 2	PITCHED ROOF 1	PITCHED ROOF 2
ROOF 1	**[30]**		**(600) {50}**	
ROOF 2	**[40]**		**(600) {100}**	
ROOF 3	**[50]**		**(600) {135}**	
ROOF 4	**[30]**		**(600) {135}**	

5.4.4. EXTERNAL GLASS SPECIFICATIONS

TYPE	LOW PRIORITY	MEDUIM PRIORITY	HIGH PRIORITY	ROOF / SKY LIGHTS
GLASS 1	Single Clear	Single Clear	Single Clear	
GLASS 2	Single Low-E Clear	Single Low-E Clear	Single Low-E Clear	
GLASS 3	Single Low-E Tint	Single Low-E Tint	Single Low-E Tint	
GLASS 4	Double Clear	Double Clear	Double Clear	
GLASS 5	Double Low-E Clear	Double Low-E Clear	Double Low-E Clear	
GLASS 6	Double Low-E Tint	Double Low-E Tint	Double Low-E Tint	
MIX 7	Single Low-E Clear	Double Clear	Double Low-E Clear	
MIX 8	Single Low-E Clear	Double Clear	Double Clear	
MIX 9	Single Low-E Clear	Single Low-E Clear	Double Clear	
	Single Clear	Single Low-E Clear	Double Clear	

5.4.5. FLOOR SPECIFICATIONS

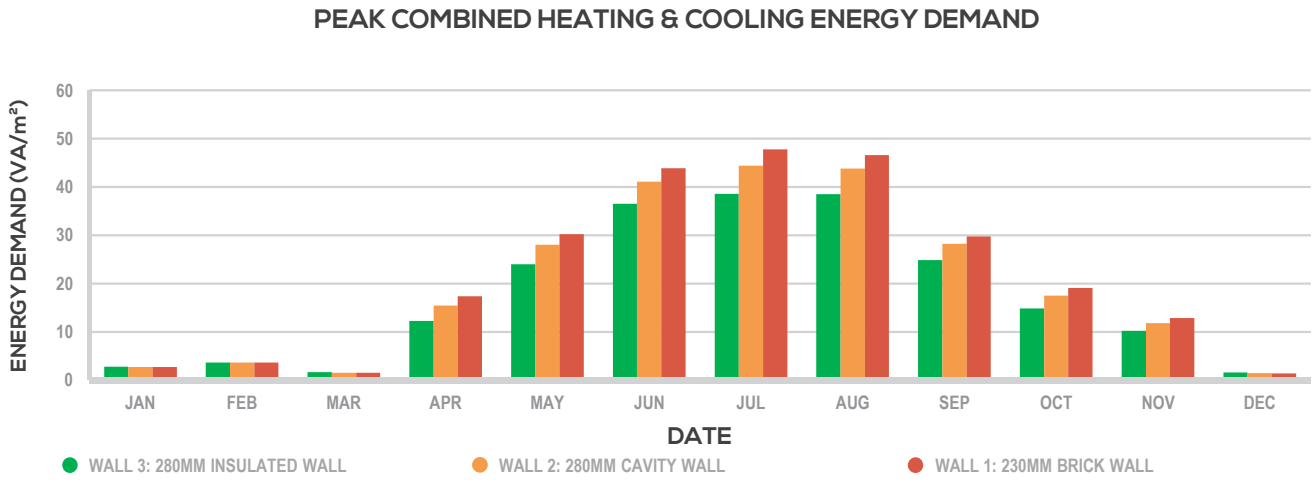
TYPE	SPECIFICATIONS	INSULATION
GROUND FLOOR	As per Architect's Specification: 85mm Concrete, 25mm Screed, 10mm Tiles	NO

FULL WALL RESULTS

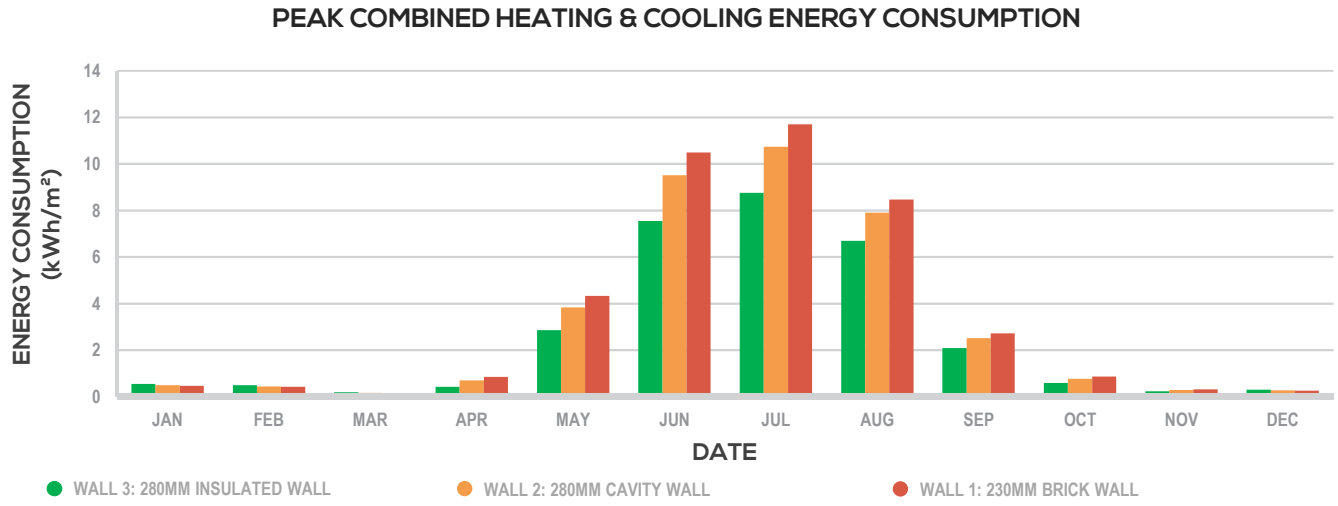
5.5 TOP 3 SIMULATION RESULTS

		Total Annual Energy Demand (VA/m²) DEMAND	Total Annual Energy Consumption (kWh/m²) CONSUMPTION
1	WALL 3: 280MM INSULATED WALL	209.19	30.68
2	WALL 2: 280MM CAVITY WALL	239.33	37.59
3	WALL 1: 230MM BRICK WALL	256.52	41.03

5.5.1. DEMAND COMPARISON



5.5.2. CONSUMPTION COMPARISON



6. ROOF SIMULATIONS

6.1. ROOF RESULTS: ENERGY PERFORMANCE

The following table illustrates the top 3 results in terms of performance of the total annual energy consumption from the lowest to highest:

		TOTAL ANNUAL ENERGY CONSUMPTION (ELECTRICITY)			
		HEATING	COOLING	TOTAL	Δ %
1	Roof 3: 135mm Fibreglass, 50mm XPS	9486 kWh	403 kWh	**9889 kWh**	
2	Roof 2: 100mm Fibreglass, 40mm XPS	9832 kWh	437 kWh	**10269 kWh**	3.84%
3	Roof 1: 50mm Fibreglass, 30mm XPS	10878 kWh	557 kWh	**11435 kWh**	15.06%
4					
5					
6					

6.2. ROOF RECOMMENDATIONS

Below is the recommended construction to achieve high energy efficiency based on the below construction materials:

FOR OPTIMUM ENERGY EFFICIENCY:

Roof 3: 135mm Fibreglass, 50mm XPS

FOR ENERGY EFFICIENCYAT A LOWER CONSTRUCTION COST THAN OPTIMUM:

Roof 2: 100mm Fibreglass, 40mm XPS

6.3. ROOF ENERGY CONSUPTION PER SEASON

SEASON	MONTH	Roof 1: 50mm Fibreglass, 30mm XPS		Roof 2: 100mm Fibreglass, 40mm XPS		Roof 3: 135mm Fibreglass, 50mm XPS	
		Heating (kWh)	Cooling (kWh)	Heating (kWh)	Cooling (kWh)	Heating (kWh)	Cooling (kWh)
SUMMER	DECEMBER	0.93	109.99	0.40	79.78	0.28	70.88
	JANUARY	0.00	171.99	0.00	139.29	0.00	129.42
	FEBRUARY	0.00	147.22	0.00	124.05	0.00	116.96
	SUMMER TOTALS	**0.93**	**429.20**	**0.40**	**343.12**	**0.28**	**317.26**
AUTUMN	MARCH	2.24	56.25	0.95	45.45	0.70	42.34
	APRIL	253.19	1.93	195.77	1.42	178.71	1.30
	MAY	1 224.69	4.43	1 055.59	3.77	1 000.77	3.57
	AUTUMN TOTALS	**1 480.11**	**62.61**	**1 252.32**	**50.64**	**1 180.18**	**47.20**
WINTER	JUNE	2 864.98	0.26	2 590.34	0.19	2 498.19	0.17
	JULY	3 180.78	0.00	2 912.47	0.00	2 822.15	0.00
	AUGUST	2 314.23	0.21	2 140.23	0.09	2 082.17	0.07
	WINTER TOTALS	**8 360.00**	**0.47**	**7 643.04**	**0.28**	**7 402.51**	**0.24**
SPRING	SEPTEMBER	744.67	2.00	681.98	1.21	661.50	1.01
	OCTOBER	227.58	21.03	199.56	13.72	190.77	12.02
	NOVEMBER	64.76	41.76	54.30	28.23	51.22	24.79
	SPRING TOTALS	**1 037.01**	**64.79**	**935.84**	**43.17**	**903.49**	**37.83**

ROOF SIMULATION INFORMATION:

6.4. CONSTRUCTION MATERIAL SPECIFICATIONS

Below is the specifications of construction materials used in the simulations that have determined the above performance results.

KEY: 🔍 Material being investigated in simulations 🏠 Constant material used in each simulation

6.4.1. SPECIFICATIONS PER SIMULATION

	EXTERNAL WALL TYPES	SPECIFICATIONS
	Wall 1: 230mm Brick Wall	2 x 115mm brick with 12mm plaster on each side
🏠	Wall 2: 280mm Cavity Wall	2 x 115mm brick with 50mm air cavity and 12mm plaster on each side
	Wall 3: 280mm Cavity Wall with Insulation	2 x 115mm brick with 50mm insulated cavity and 12mm plaster on each side

6.4.2. INTERNAL WALL SPECIFICATIONS

	TYPE	SPECIFICATIONS
🏠	INTERNAL WALLS	1 x 115mm Brick with 12mm plaster on each side

6.4.3. ROOF SPECIFICATIONS

FLAT ROOF 1	Architect's Specification: 40mm Gravel, [XX]mm XPS, 4mm Bitumen, 40mm Screed, 170mm Concrete
FLAT ROOF 2	
PITCHED ROOF 1	Architect's Specification: 0.5mm Sheeting, (0.01mm Sisalation), (YY)mm Airspace, {ZZ}mm Fibre glass insulation, 6mm Ceiling board
PITCHED ROOF 2	

	TYPE	FLAT ROOF 1	FLAT ROOF 2	PITCHED ROOF 1	PITCHED ROOF 2
🔍	ROOF 1	**[30]**		**(600) {50}**	
🔍	ROOF 2	**[40]**		**(600) {100}**	
🔍	ROOF 3	**[50]**		**(600) {135}**	
	ROOF 4	**[30]**		**(600) {135}**	

6.4.4. EXTERNAL GLASS SPECIFICATIONS

TYPE	LOW PRIORITY	MEDUIM PRIORITY	HIGH PRIORITY	ROOF / SKY LIGHTS
GLASS 1	Single Clear	Single Clear	Single Clear	Single Clear
GLASS 2	Single Low-E Clear	Single Low-E Clear	Single Low-E Clear	Single Low-E Clear
GLASS 3	Single Low-E Tint	Single Low-E Tint	Single Low-E Tint	Single Low-E Tint
GLASS 4	Double Clear	Double Clear	Double Clear	Double Clear
GLASS 5	Double Low-E Clear	Double Low-E Clear	Double Low-E Clear	Double Low-E Clear
GLASS 6	Double Low-E Tint	Double Low-E Tint	Double Low-E Tint	Double Low-E Tint
MIX 7	Single Low-E Clear	Double Clear	Double Low-E Clear	Double Low-E Clear
MIX 8	Single Low-E Clear	Double Clear	Double Clear	Double Clear
MIX 9	Single Low-E Clear	Single Low-E Clear	Double Clear	Double Clear
🏠	Single Clear	Single Low-E Clear	Double Clear	Single Clear

6.4.5. FLOOR SPECIFICATIONS

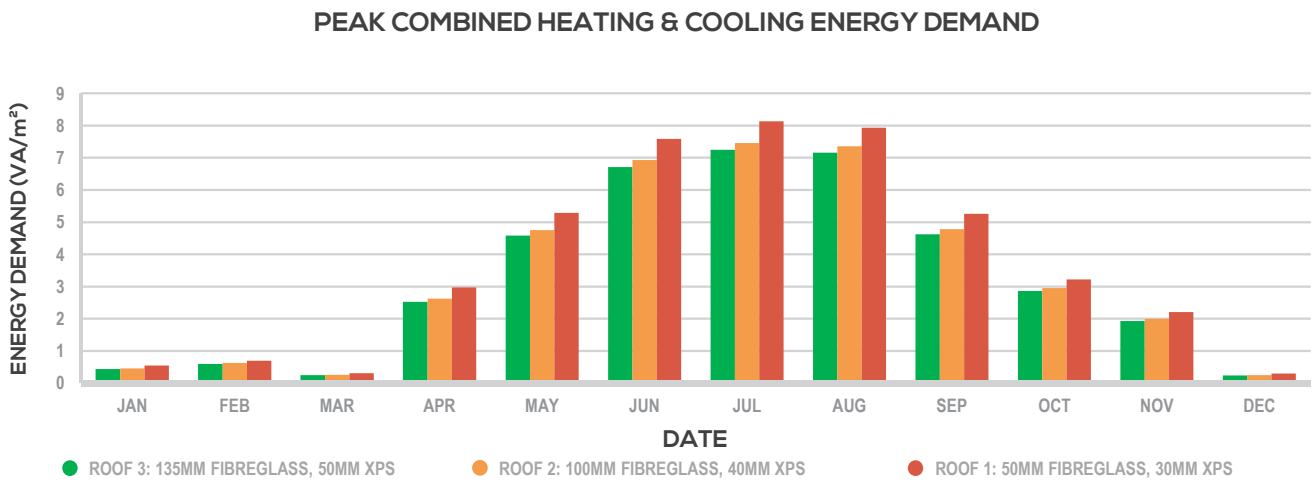
	TYPE	SPECIFICATIONS	INSULATION
🏠	GROUND FLOOR	As per Architect's Specification: 85mm Concrete, 25mm Screed, 10mm Tiles	NO

FULL ROOF RESULTS

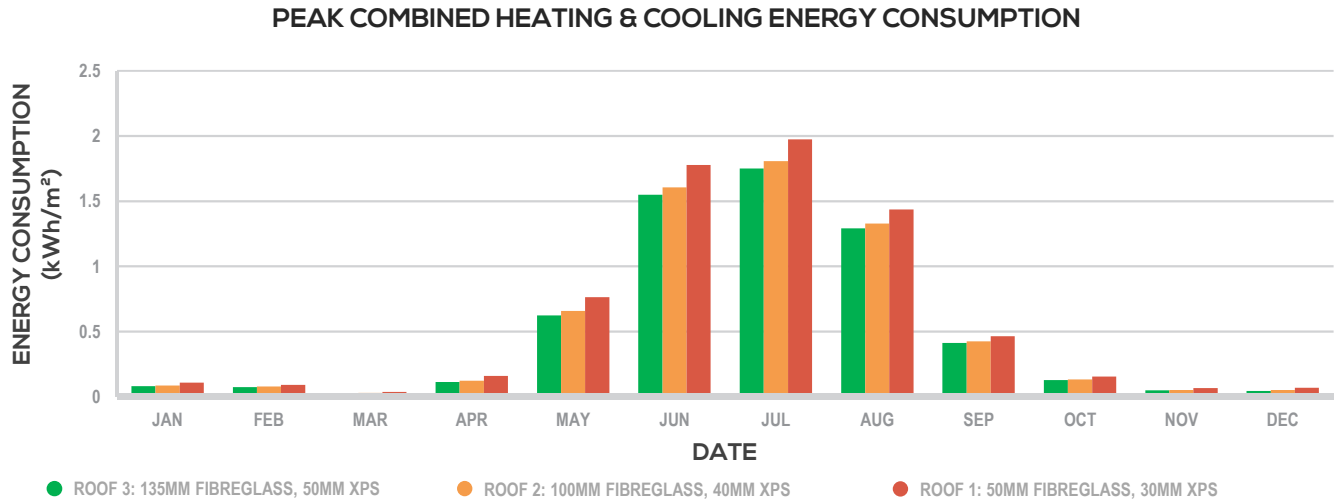
6.5 TOP 3 SIMULATION RESULTS

		Total Annual Energy Demand (VA/m²) DEMAND	Total Annual Energy Consumption (kWh/m²) CONSUMPTION
1	Roof 3: 135mm Fibreglass, 50mm XPS	39.10	6.13
2	Roof 2: 100mm Fibreglass, 40mm XPS	40.40	6.37
3	Roof 1: 50mm Fibreglass, 30mm XPS	44.38	7.09

6.5.1. DEMAND COMPARISON



6.5.2. CONSUMPTION COMPARISON



7. GLASS THROUGHOUT SIMULATIONS

7.1. GLASS THROUGHOUT RESULTS: ENERGY PERFORMANCE

The following table illustrates the top 3 results in terms of performance of the total annual energy consumption from the lowest to highest:

		TOTAL ANNUAL ENERGY CONSUMPTION (ELECTRICITY)			
		HEATING	COOLING	TOTAL	Δ %
1	Double Low-E Clear Throughout	8609 kWh	231 kWh	**8840 kWh**	
2	Double Clear Throughout	8825 kWh	426 kWh	**9251 kWh**	**4.64%**
3	Double Low-E Tint	9661 kWh	90 kWh	**9751 kWh**	**9.85%**
4	Single Low-E Clear	10026 kWh	366 kWh	10392 kWh	15.92%
5	Single Low-E Tint	11091 kWh	188 kWh	11279 kWh	23.47%
6	Single Clear	11269 kWh	366 kWh	11829 kWh	26.50%

7.2. GLASS THROUGHOUT RECOMMENDATIONS

Below is the recommended construction to achieve high energy efficiency based on the below construction materials:

FOR OPTIMUM ENERGY EFFICIENCY:

Double Low-E Clear Throughout

FOR ENERGY EFFICIENCYAT A LOWER CONSTRUCTION COST THAN OPTIMUM:

Double Clear Throughout

7.3. GLASS THROUGHOUT ENERGY CONSUPTION PER SEASON

SEASON	MONTH	Double Clear Throughout		Double Low-E Clear Throughout		Double Low-E Tint	
		Heating (kWh)	Cooling (kWh)	Heating (kWh)	Cooling (kWh)	Heating (kWh)	Cooling (kWh)
SUMMER	DECEMBER	0.00	75.64	0.00	37.52	0.02	11.72
	JANUARY	0.00	136.96	0.00	83.17	0.00	35.29
	FEBRUARY	0.00	123.24	0.00	77.14	0.00	35.15
	SUMMER TOTALS	**0.00**	**335.84**	**0.00**	**197.83**	**0.02**	**82.17**
AUTUMN	MARCH	0.03	45.31	0.03	21.01	0.07	5.95
	APRIL	138.26	1.30	115.88	0.02	154.84	0.00
	MAY	907.37	3.59	867.45	0.21	1 010.95	0.00
	AUTUMN TOTALS	**1 045.66**	**50.20**	**983.35**	**21.23**	**1 165.86**	**5.95**
WINTER	JUNE	2 341.87	0.17	2 270.21	0.00	2 514.51	0.00
	JULY	2 665.29	0.00	2 608.84	0.00	2 867.77	0.00
	AUGUST	1 968.49	0.07	1 962.89	0.00	2 176.90	0.00
	WINTER TOTALS	**6 975.65**	**0.24**	**6 841.94**	**0.00**	**7 559.18**	**0.00**
SPRING	SEPTEMBER	603.15	1.02	596.20	0.00	692.18	0.00
	OCTOBER	161.99	12.14	154.45	3.08	196.86	0.34
	NOVEMBER	38.60	26.16	32.97	9.04	46.61	1.73
	SPRING TOTALS	**803.73**	**39.32**	**783.62**	**12.11**	**935.65**	**2.07**

GLASS THROUGHOUT SIMULATION INFORMATION:

7.4. CONSTRUCTION MATERIAL SPECIFICATIONS

Below is the specifications of construction materials used in the simulations that have determined the above performance results.

KEY: 🔍 Material being investigated in simulations 🏠 Constant material used in each simulation

7.4.1. SPECIFICATIONS PER SIMULATION

	EXTERNAL WALL TYPES	SPECIFICATIONS
	WALL 1: 230MM BRICK WALL	2 x 110mm brick with 12mm plaster on each side
🏠	WALL 2: 280MM CAVITY WALL	2 x 110mm brick with 50mm air cavity and 12mm plaster on each side
	WALL 3: 280MM INSULATED WALL	2 x 110mm brick with 50mm insulated cavity and 12mm plaster on each side

7.4.2. INTERNAL WALL SPECIFICATIONS

	TYPE	SPECIFICATIONS
🏠	INTERNAL WALLS	1 x 115mm Brick with 12mm plaster on each side

7.4.3. ROOF SPECIFICATIONS

FLAT ROOF 1	Architect's Specification: 40mm Gravel, [XX]mm XPS, 4mm Bitumen, 40mm Screed, 170mm Concrete
FLAT ROOF 2	
PITCHED ROOF 1	Architect's Specification: 0.5mm Sheeting, (0.01mm Sisalation), (YY)mm Airspace, {ZZ}mm Fibre glass insulation, 6mm Ceiling board
PITCHED ROOF 2	

	TYPE	FLAT ROOF 1	FLAT ROOF 2	PITCHED ROOF 1	PITCHED ROOF 2
	ROOF 1	**[30]**		**(600) {50}**	
🏠	ROOF 2	**[40]**		**(600) {100}**	
	ROOF 3	**[50]**		**(600) {135}**	
	ROOF 4	**[30]**		**(600) {135}**	

7.4.4. EXTERNAL GLASS SPECIFICATIONS

	TYPE	LOW PRIORITY	MEDUIM PRIORITY	HIGH PRIORITY	ROOF / SKY LIGHTS
🔍	GLASS 1	Single Clear	Single Clear	Single Clear	
🔍	GLASS 2	Single Low-E Clear	Single Low-E Clear	Single Low-E Clear	
🔍	GLASS 3	Single Low-E Tint	Single Low-E Tint	Single Low-E Tint	
🔍	GLASS 4	Double Clear	Double Clear	Double Clear	
🔍	GLASS 5	Double Low-E Clear	Double Low-E Clear	Double Low-E Clear	
🔍	GLASS 6	Double Low-E Tint	Double Low-E Tint	Double Low-E Tint	
	MIX 7	Single Low-E Clear	Double Clear	Double Low-E Clear	
	MIX 8	Single Low-E Clear	Double Clear	Double Clear	
	MIX 9	Single Low-E Clear	Single Low-E Clear	Double Clear	
		Single Clear	Single Low-E Clear	Double Clear	

7.4.5. FLOOR SPECIFICATIONS

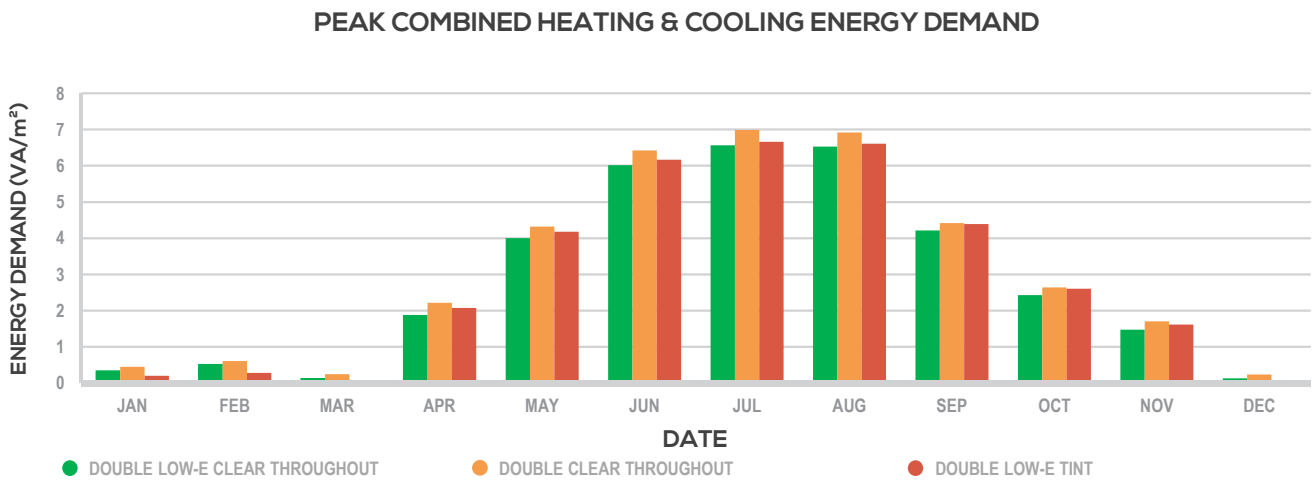
	TYPE	SPECIFICATIONS	INSULATION
🏠	GROUND FLOOR	As per Architect's Specification: 85mm Concrete, 25mm Screed, 10mm Tiles	NO

FULL GLASS THROUGHOUT RESULTS

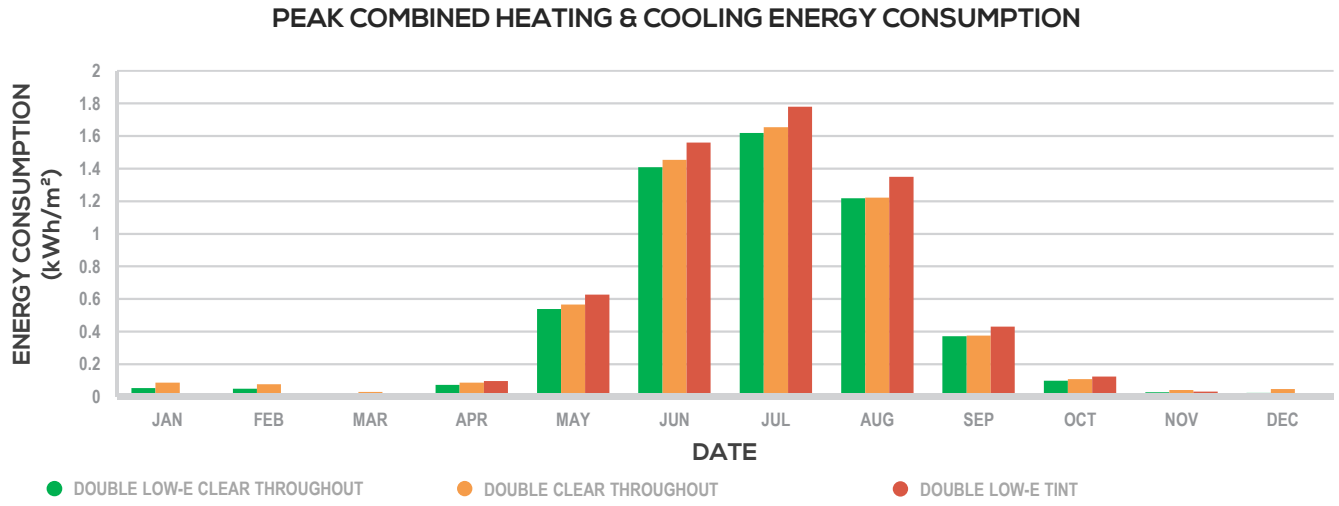
7.5 TOP 3 SIMULATION RESULTS

		Total Annual Energy Demand (VA/m²) DEMAND	Total Annual Energy Consumption (kWh/m²) CONSUMPTION
1	Double Low-E Clear Throughout	34.21	5.48
2	Double Clear Throughout	37.14	5.74
3	Double Low-E Tint	34.83	6.05

7.5.1. DEMAND COMPARISON



7.5.2 CONSUMPTION COMPARISON



8. GLASS MIX OPTIONS SIMULATIONS

8.1. GLASS MIX OPTIONS RESULTS: ENERGY PERFORMANCE

The following table illustrates the top 3 results in terms of performance of the total annual energy consumption from the lowest to highest:

		TOTAL ANNUAL ENERGY CONSUMPTION (ELECTRICITY)			
		HEATING	COOLING	TOTAL	Δ %
1	Double Low-E Clear	8609 kWh	231 kWh	**8840 kWh**	
2	Mix 7	8765 kWh	323 kWh	**9088 kWh**	**2.81%**
3	Double Clear Throughout	8825 kWh	426 kWh	**9251 kWh**	**4.52%**
4	Mix 8	8825 kWh	426 kWh	9251 kWh	
5	Double Low-E Tint	9661 kWh	90 kWh	9751 kWh	
6	Mix 9	9486 kWh	403 kWh	9889 kWh	

8.2. GLASS MIX OPTIONS RECOMMENDATIONS

Below is the recommended construction to achieve high energy efficiency based on the below construction materials:

FOR OPTIMUM ENERGY EFFICIENCY:	
Double Low-E Clear	As per specifications
FOR ENERGY EFFICIENCYAT A LOWER CONSTRUCTION COST THAN OPTIMUM:	
Mix 7	As per specifications

8.3. GLASS MIX OPTIONS ENERGY CONSUPTION PER SEASON

SEASON	MONTH	Double Clear Throughout		Mix 7		Double Low-E Clear	
		Heating (kWh)	Cooling (kWh)	Heating (kWh)	Cooling (kWh)	Heating (kWh)	Cooling (kWh)
SUMMER	DECEMBER	0.00	75.64	0.00	57.95	0.00	37.52
	JANUARY	0.00	136.96	0.00	111.72	0.00	83.17
	FEBRUARY	0.00	123.24	0.00	101.15	0.00	77.14
	SUMMER TOTALS	**0.00**	**335.84**	**0.00**	**270.82**	**0.00**	**197.83**
AUTUMN	MARCH	0.03	45.31	0.04	30.59	0.03	21.01
	APRIL	138.26	1.30	132.26	0.02	115.88	0.02
	MAY	907.37	3.59	895.95	0.21	867.45	0.21
	AUTUMN TOTALS	**1 045.66**	**50.20**	**1 028.24**	**30.83**	**983.35**	**21.23**
WINTER	JUNE	2 341.87	0.17	2 317.48	0.00	2 270.21	0.00
	JULY	2 665.29	0.00	2 648.46	0.00	2 608.84	0.00
	AUGUST	1 968.49	0.07	1 973.07	0.00	1 962.89	0.00
	WINTER TOTALS	**6 975.65**	**0.24**	**6 939.00**	**0.00**	**6 841.94**	**0.00**
SPRING	SEPTEMBER	603.15	1.02	602.22	0.00	596.20	0.00
	OCTOBER	161.99	12.14	159.08	5.43	154.45	3.08
	NOVEMBER	38.60	26.16	36.61	16.00	32.97	9.04
	SPRING TOTALS	**803.73**	**39.32**	**797.91**	**21.43**	**783.62**	**12.11**

GLASS MIX OPTIONS SIMULATION INFORMATION:

8.4. CONSTRUCTION MATERIAL SPECIFICATIONS

Below is the specifications of construction materials used in the simulations that have determined the above performance results.

KEY: 🔍 Material being investigated in simulations 🏠 Constant material used in each simulation

8.4.1. SPECIFICATIONS PER SIMULATION

	EXTERNAL WALL TYPES	SPECIFICATIONS
	Wall 1: 230mm Brick Wall	2 x 115mm Brick with 12mm plaster on each side
🏠	Wall 2: 280mm Cavity Wall	2 x 115mm Brick, 50mm Cavity with 12mm plaster on each side
	Wall 3: 280mm Cavity Wall with Insulation	2 x 115mm Brick, 50mm Insulation with 12mm plaster on each side

8.4.2. INTERNAL WALL SPECIFICATIONS

	TYPE	SPECIFICATIONS
🏠	INTERNAL WALLS	1 x 115mm Brick with 12mm plaster on each side

8.4.3. ROOF SPECIFICATIONS

FLAT ROOF 1	Architect's Specification: 40mm Gravel, [XX]mm XPS, 4mm Bitumen, 40mm Screed, 170mm Concrete
FLAT ROOF 2	
PITCHED ROOF 1	Architect's Specification: 0.5mm Sheeting, (0.01mm Sisalation), (YY)mm Airspace, {ZZ}mm Fibre glass insulation, 6mm Ceiling board
PITCHED ROOF 2	

	TYPE	FLAT ROOF 1	FLAT ROOF 2	PITCHED ROOF 1	PITCHED ROOF 2
	ROOF 1	**[30]**		**(600) {50}**	
🏠	ROOF 2	**[40]**		**(600) {100}**	
	ROOF 3	**[50]**		**(600) {135}**	
	ROOF 4	**[30]**		**(600) {135}**	

8.4.4. EXTERNAL GLASS SPECIFICATIONS

	TYPE	LOW PRIORITY	MEDUIM PRIORITY	HIGH PRIORITY	ROOF / SKY LIGHTS
	GLASS 1	Single Clear	Single Clear	Single Clear	
	GLASS 2	Single Low-E Clear	Single Low-E Clear	Single Low-E Clear	
	GLASS 3	Single Low-E Tint	Single Low-E Tint	Single Low-E Tint	
	GLASS 4	Double Clear	Double Clear	Double Clear	
	GLASS 5	Double Low-E Clear	Double Low-E Clear	Double Low-E Clear	
	GLASS 6	Double Low-E Tint	Double Low-E Tint	Double Low-E Tint	
🔍	MIX 7	Single Low-E Clear	Double Clear	Double Low-E Clear	
🔍	MIX 8	Single Low-E Clear	Double Clear	Double Clear	
🔍	MIX 9	Single Low-E Clear	Single Low-E Clear	Double Clear	
		Single Clear	Single Low-E Clear	Double Clear	

8.4.5. FLOOR SPECIFICATIONS

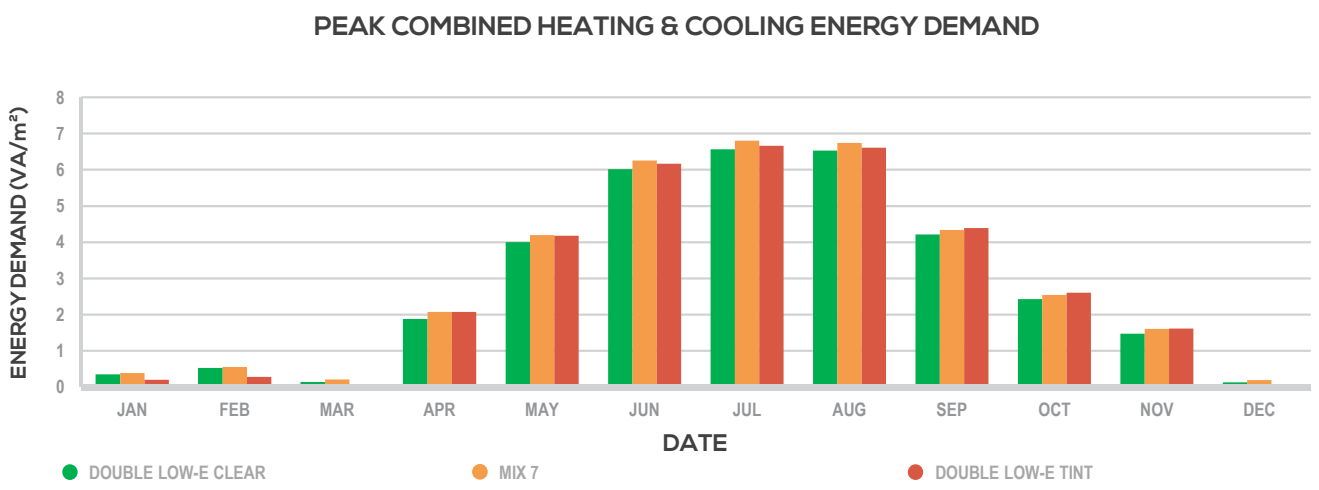
	TYPE	SPECIFICATIONS	INSULATION
🏠	GROUND FLOOR	As per Architect's Specification: 85mm Concrete, 25mm Screed, 10mm Tiles	NO

FULL GLASS MIX OPTIONS RESULTS

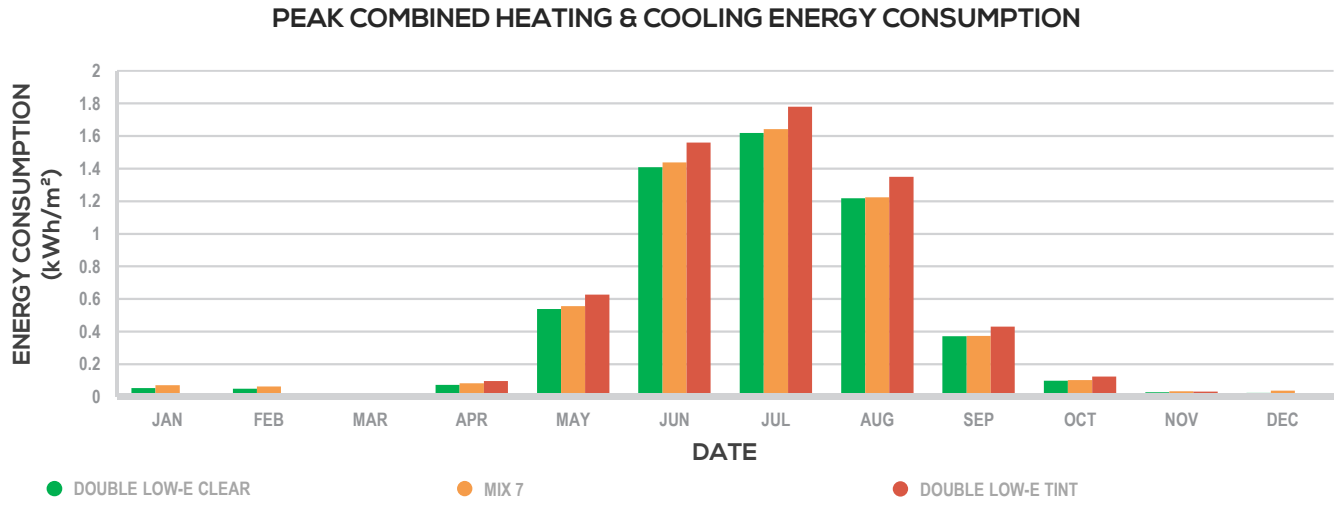
8.5 TOP 3 SIMULATION RESULTS

		Total Annual Energy Demand (VA/m²) DEMAND	Total Annual Energy Consumption (kWh/m²) CONSUMPTION
1	Double Low-E Clear	34.21	5.48
2	Mix 7	35.87	5.63
3	Double Low-E Tint	34.83	6.05

8.5.1. DEMAND COMPARISON



8.5.2. CONSUMPTION COMPARISON



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9. TOP PERFORMERS SIMULATIONS

9.1. TOP PERFORMERS RESULTS: ENERGY PERFORMANCE

The following table illustrates the top 3 results in terms of performance of the total annual energy consumption from the lowest to highest:

		TOTAL ANNUAL ENERGY CONSUMPTION (ELECTRICITY)			
		HEATING	COOLING	TOTAL	Δ %
1	Top Sim 1	6718 kWh	259 kWh	**6976 kWh**	
2	Top sim 2 with insulation under slab	6662 kWh	**2183 kWh**	8844 kWh	26.77%
3	Top Sim 2	9109 kWh	356 kWh	**9465 kWh**	**28.14%**
4	Top Sim 3	11147 kWh	558 kWh	11705 kWh	**49.96%**
5					
6					

9.2. TOP PERFORMERS RECOMMENDATIONS

Below is the recommended construction to achieve high energy efficiency based on the below construction materials:

FOR OPTIMUM ENERGY EFFICIENCY:

Top Sim 1

FOR ENERGY EFFICIENCYAT A LOWER CONSTRUCTION COST THAN OPTIMUM:

Top Sim 2

9.3. TOP PERFORMERS ENERGY CONSUPTION PER SEASON

SEASON	MONTH	Top Sim 2		Top sim 2 with insulation under slab		Top Sim 1	
		Heating (kWh)	Cooling (kWh)	Heating (kWh)	Cooling (kWh)	Heating (kWh)	Cooling (kWh)
SUMMER	DECEMBER	0.56	111.36	0.02	66.54	0.00	42.29
	JANUARY	0.00	172.61	0.00	121.36	0.00	91.84
	FEBRUARY	0.00	147.65	0.00	108.11	0.00	84.26
	SUMMER TOTALS	**0.56**	**431.62**	**0.02**	**296.02**	**0.00**	**218.39**
AUTUMN	MARCH	1.72	55.54	0.09	33.55	0.00	26.02
	APRIL	254.19	1.43	147.70	0.02	54.88	0.24
	MAY	1 263.49	3.65	950.58	0.29	605.53	1.05
	AUTUMN TOTALS	**1 519.40**	**60.62**	**1 098.38**	**33.86**	**660.41**	**27.31**
WINTER	JUNE	2 966.98	0.13	2 410.32	0.00	1 740.38	0.01
	JULY	3 278.75	0.00	2 739.66	0.00	2 071.85	0.00
	AUGUST	2 352.94	0.15	2 031.63	0.00	1 636.40	0.00
	WINTER TOTALS	**8 598.67**	**0.28**	**7 181.60**	**0.00**	**5 448.62**	**0.01**
SPRING	SEPTEMBER	742.74	1.93	622.46	0.00	483.09	0.00
	OCTOBER	224.49	21.14	167.54	6.72	107.00	2.83
	NOVEMBER	61.35	42.13	39.28	19.22	18.59	10.11
	SPRING TOTALS	**1 028.58**	**65.20**	**829.27**	**25.94**	**608.68**	**12.94**

TOP PERFORMERS SIMULATION INFORMATION:

9.4. CONSTRUCTION MATERIAL SPECIFICATIONS

Below is the specifications of construction materials used in the simulations that have determined the above performance results.

KEY: Material being investigated in simulations | Constant material used in each simulation

9.4.1. SPECIFICATIONS PER SIMULATION

	EXTERNAL WALL TYPES	SPECIFICATIONS
Top 1	WALL 1: 230MM BRICK WALL	2 x 115mm brick with 12mm plaster on each side
Top 2	WALL 2: 280MM CAVITY WALL	2 x 115mm brick with 50mm air cavity and 12mm plaster on each side
Top 3	WALL 3: 280MM INSULATED WALL	2 x 115mm brick with 50mm insulated cavity and 12mm plaster on each side

9.4.2. INTERNAL WALL SPECIFICATIONS

	TYPE	SPECIFICATIONS
All	INTERNAL WALLS	1 x 115mm Brick with 12mm plaster on each side

9.4.3. ROOF SPECIFICATIONS

FLAT ROOF 1	Architect's Specification: 40mm Gravel, [XX]mm XPS, 4mm Bitumen, 40mm Screed, 170mm Concrete
FLAT ROOF 2	
PITCHED ROOF 1	Architect's Specification: 0.5mm Sheeting, (0.01mm Sisalation), (YY)mm Airspace, {ZZ}mm Fibre glass insulation, 6mm Ceiling board
PITCHED ROOF 2	

	TYPE	FLAT ROOF 1	FLAT ROOF 2	PITCHED ROOF 1	PITCHED ROOF 2
Top 3	ROOF 1	**[30]**		**(600) {50}**	
Top 2	ROOF 2	**[40]**		**(600) {100}**	
Top 1	ROOF 3	**[50]**		**(600) {135}**	
	ROOF 4	[30]		(600) {135}	

9.4.4. EXTERNAL GLASS SPECIFICATIONS

	TYPE	LOW PRIORITY	MEDUIM PRIORITY	HIGH PRIORITY	ROOF / SKY LIGHTS
	GLASS 1	Single Clear	Single Clear	Single Clear	
	GLASS 2	Single Low-E Clear	Single Low-E Clear	Single Low-E Clear	
	GLASS 3	Single Low-E Tint	Single Low-E Tint	Single Low-E Tint	
Top 3	GLASS 4	Double Clear	Double Clear	Double Clear	
Top 1	GLASS 5	Double Low-E Clear	Double Low-E Clear	Double Low-E Clear	
	GLASS 6	Double Low-E Tint	Double Low-E Tint	Double Low-E Tint	
Top 2	MIX 7	Single Low-E Clear	Double Clear	Double Low-E Clear	
	MIX 8	Single Low-E Clear	Double Clear	Double Clear	
	MIX 9	Single Low-E Clear	Single Low-E Clear	Double Clear	
		Single Clear	Single Low-E Clear	Double Clear	

9.4.5. FLOOR SPECIFICATIONS

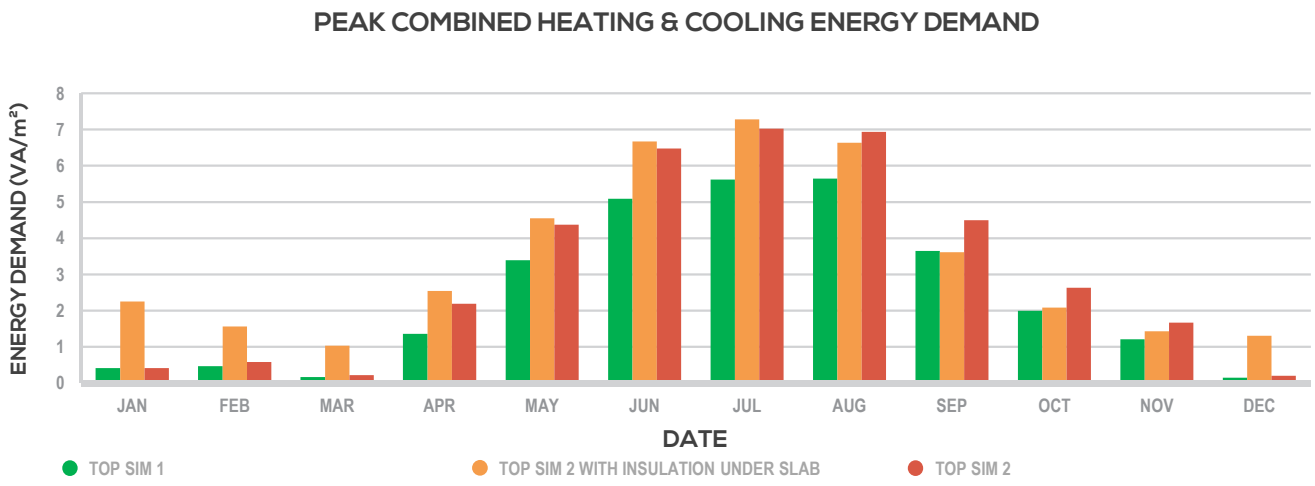
	TYPE	SPECIFICATIONS	INSULATION
All	GROUND FLOOR	As per Architect's Specification: 85mm Concrete, 25mm Screed, 10mm Tiles	NO

TOP PERFORMERS RESULTS

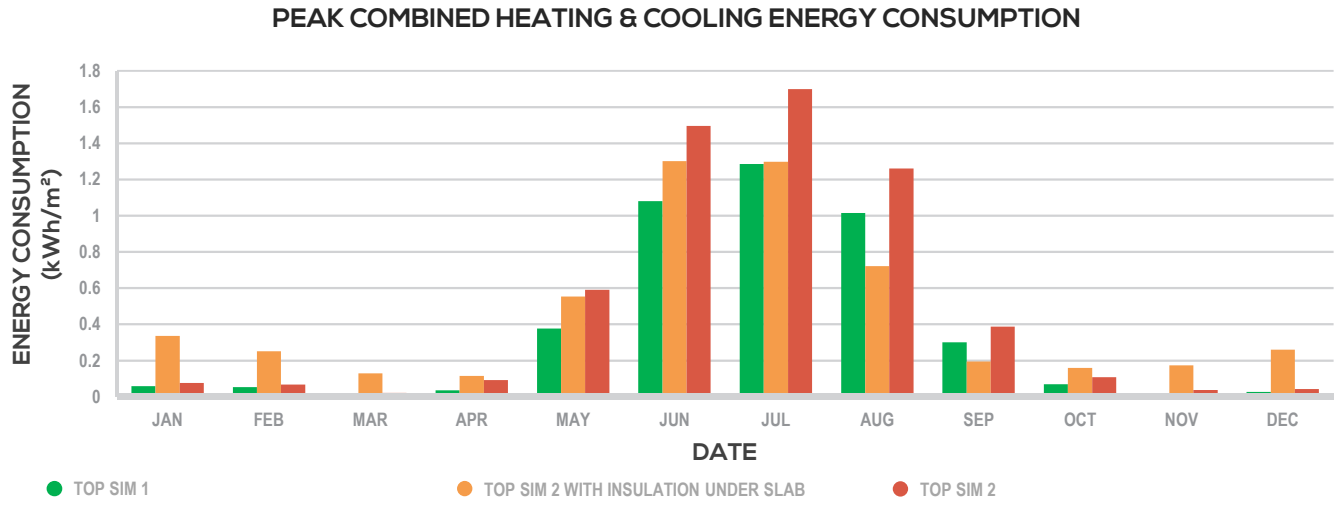
9.5 TOP 3 SIMULATION RESULTS

		Total Annual Energy Demand (VA/m²) DEMAND	Total Annual Energy Consumption (kWh/m²) CONSUMPTION
1	Top Sim 1	29.13	4.33
2	Top sim 2 with insulation under slab	40.93	5.48
3	Top Sim 2	37.19	5.87

9.5.1. DEMAND COMPARISON



9.5.2. CONSUMPTION COMPARISON



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