13161

Somfy

LEED Related Analysis

Results Analysis

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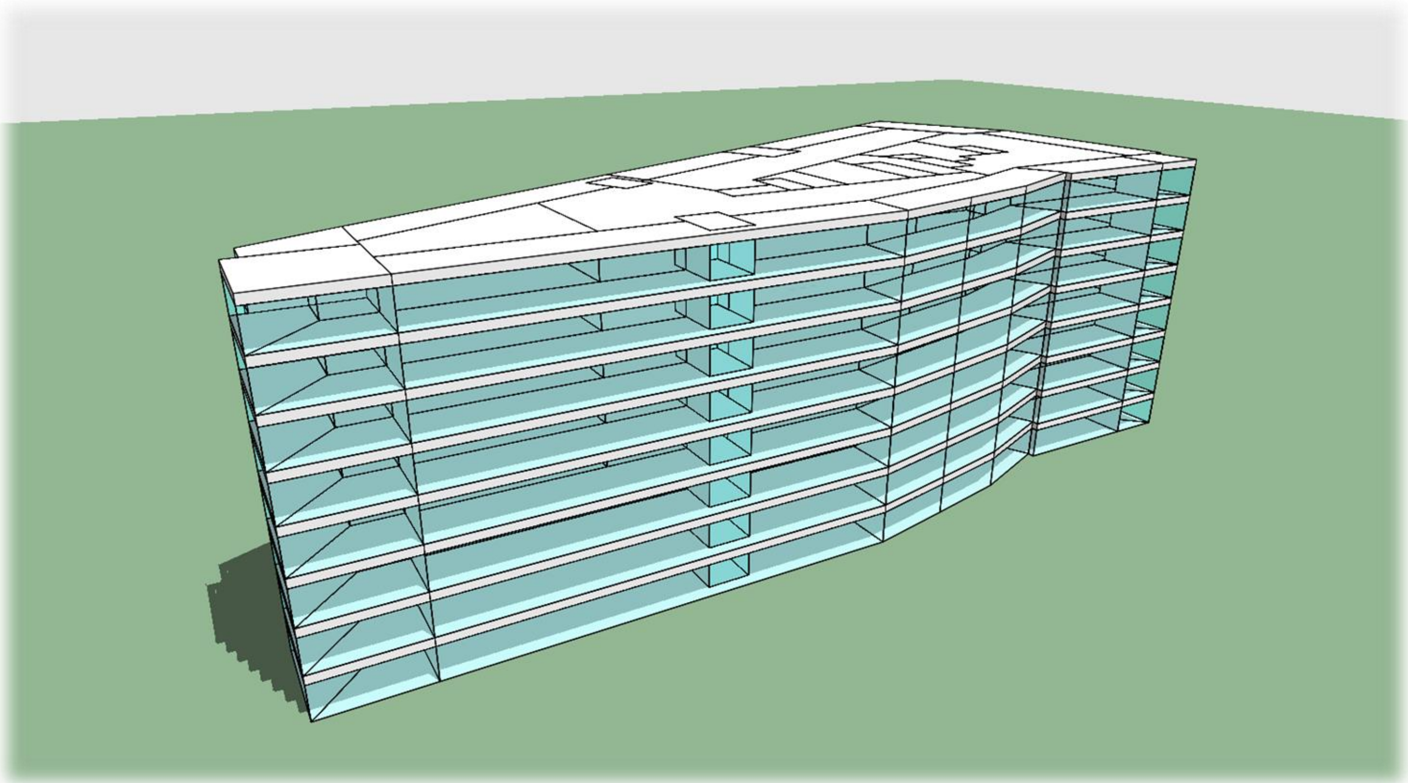


1 Executive Summary

This study was conducted to ascertain the potential impact of automated shading powered by Somfy with respect to building energy performance. IES determined that while adding automated shading has a positive impact the potential can be amplified and therefore more impressive if the strategy is developed within an integrated design process.

Initially the primary focus of the study was on energy performance of the same building across four geographical areas each with unique climate characteristics. IES identified that each location presented a unique opportunity to optimize the building's energy performance and the potential impact went beyond energy use. In fact, visual and thermal comfort benefits were more significant, especially if the application considered different options in shading location, shading material, operational sequences, daylighting controls and glazing options.

It was that identified automated shading powered by Somfy can be an integral part of an integrated design solution since it can impact thermal comfort, daylight performance, visual comfort and employee productivity in addition to energy efficiency. A customized automated shading solution powered by Somfy could contribute up to four (4) LEED credits including:

- **Integrative Process (IPc1)**
- **Energy optimization (EAp2/EAc1)**
- **Daylighting and glare control (EQc8)**
- **Thermal comfort (EQ5)**

Additionally and complimentarily, the customized automated shading solution could contribute up to six (6) Well Building Standard Features:

Light

- **54 Circadian**
- **56 Solar Glare**
- **60 Automated Shading**
- **61 Daylighting Fenestration (External Shading)**

Comfort

- **76 Thermal comfort**
- **83 Radiant Thermal Comfort**

Finally, while assessing the energy performance was important, the study identified the most effective solutions included those which balanced energy savings with improved daylighting performance and visual comfort, as well as thermal comfort. In order to achieve the highest impact, the performance characteristics of the glass visible light transmittance (VLT), solar heat gain coefficient (SHGC) and U-value need to be optimized.

When looking at the building in this integrated and holistic manner, the study identified the building architectural form, its function and climate zone were all important factors requiring careful consideration.

Overall the study provided insight into a working methodology for project teams to simulate Somfy shading products across these factors in the IES Virtual Environment.

2 Introduction

Integrated Environmental Solutions Ltd (IES) were instructed by Somfy, North America to undertake a series of building simulations to assist in demonstrating the impact of utilizing automated shade technology within a building design.

Automated shades can be used to assist in demonstrating improved performance both within LEED credits as well as other Building performance metrics such as WELL.

For LEED energy modelling credits (Energy & Atmosphere Prerequisite 2 & Energy & Atmosphere Credit 1) the benefit of movable shades can only be demonstrated when they are controlled via an automated system. Demonstrating compliance with LEED Credit Indoor Environmental Quality 8.1 can also be performed when employing an automated shade system.

Under the WELL rating system the incorporation of automated shades can allow designers to demonstrate that an optimization has been achieved towards the Light concept.

IES performed a series of simulation assessments comparing the performance of an office building modelled with high performance solar control glass to a low emissivity glass selection with an automated shade control.

The simulations investigated the impact the automated shade had on energy consumption, building loads and occupant comfort.

This report summarises the key inputs selected for the building model and intended to be used within the analysis.

3 Model Geometry

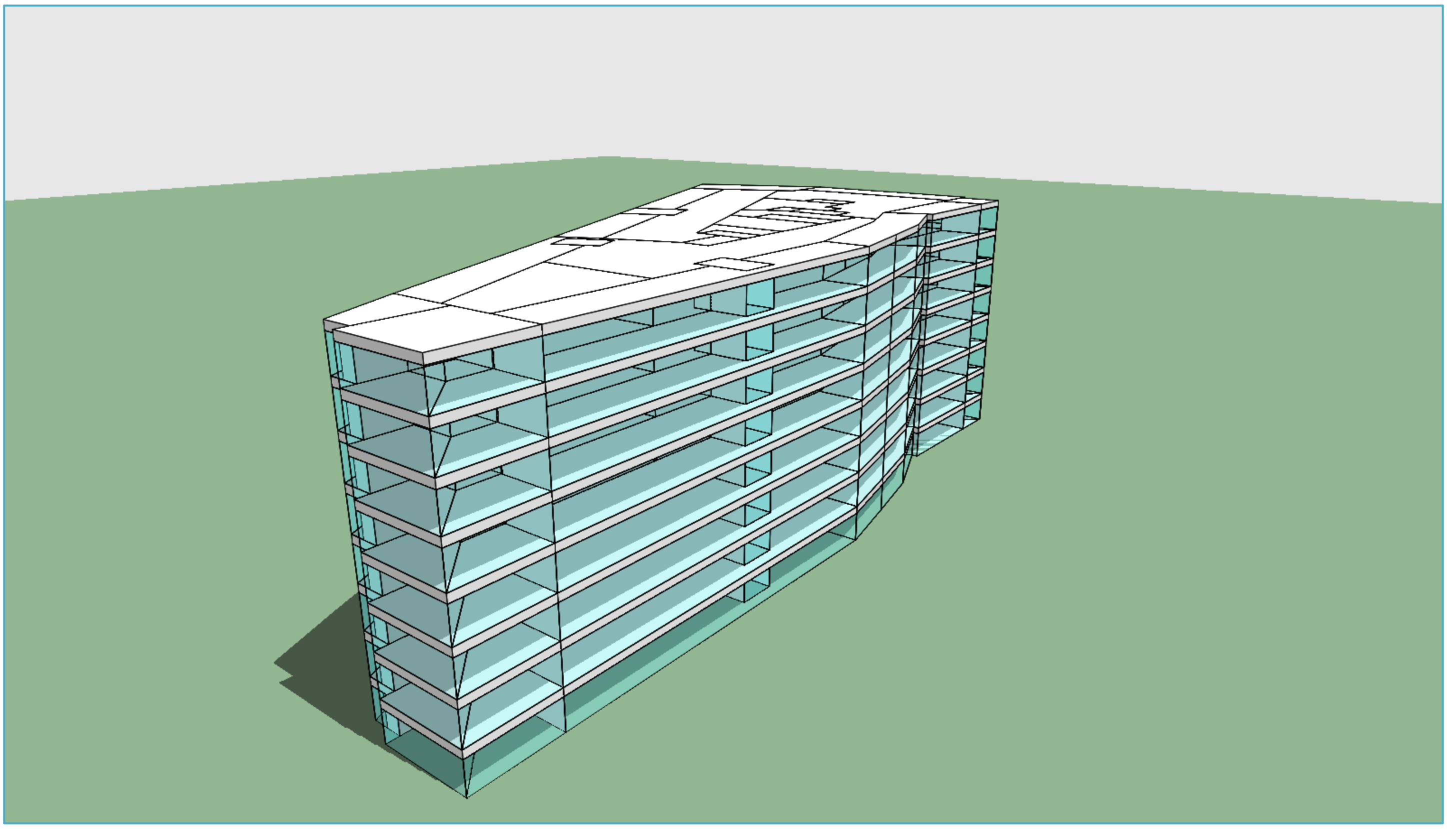
The model is an approximately 200,000 square foot open plan office development across 8 stories. The building incorporates an overall window to wall ratio of approximately 63% including substantial glazing on the south façade.

Details of the overall glazing distribution are shown in the table below.

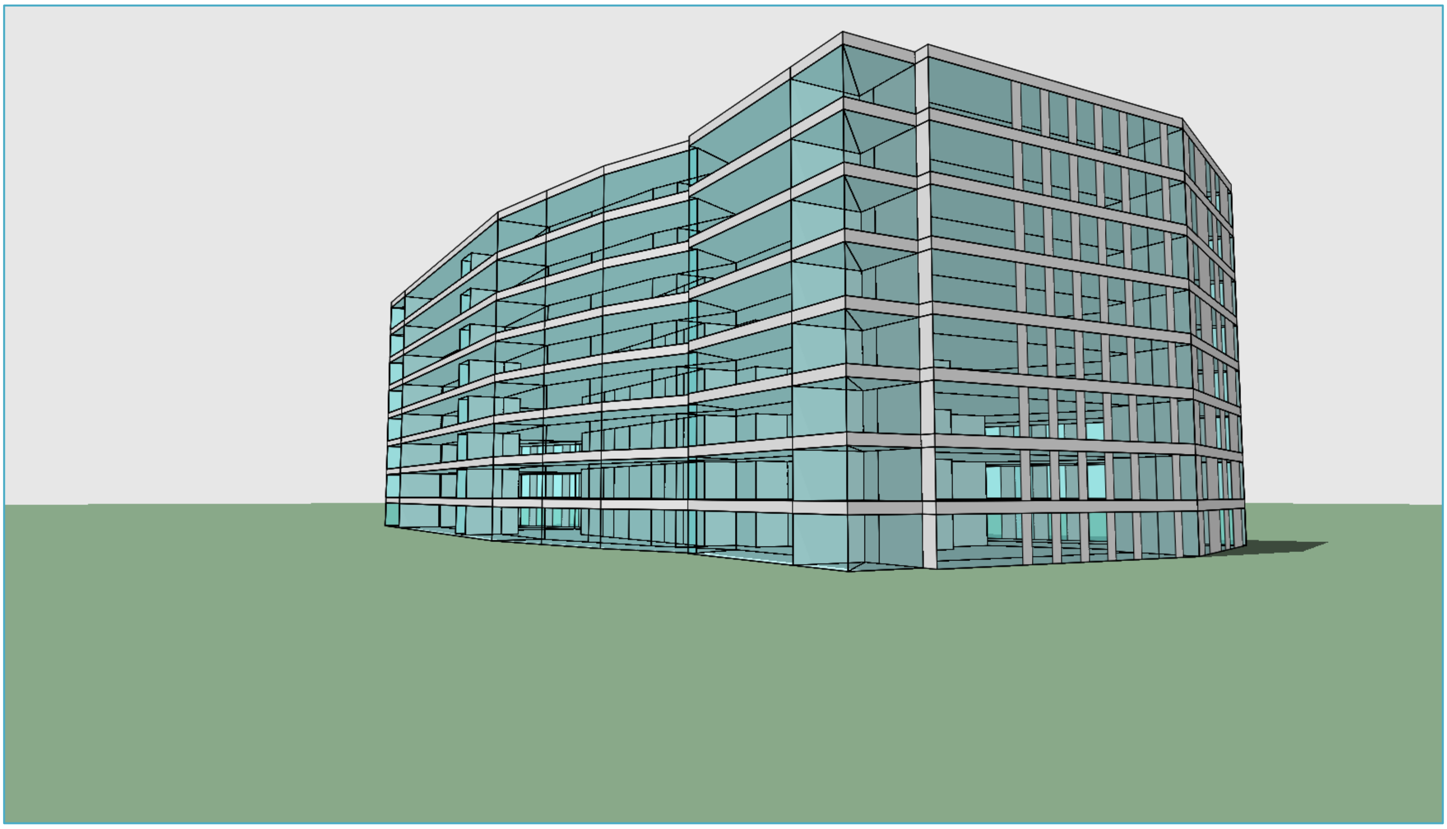
Orientation	Above-grade wall area ft²	Vertical glazing area	
		ft²	%
North	12,360	6,498	52.6%
East	25,554	20,288	79.4%
South	3,392	2,405	70.9%
West	12,360	6,498	52.6%
Overall	**66,887**	**42,062**	**62.8%**

3.1 Plan View

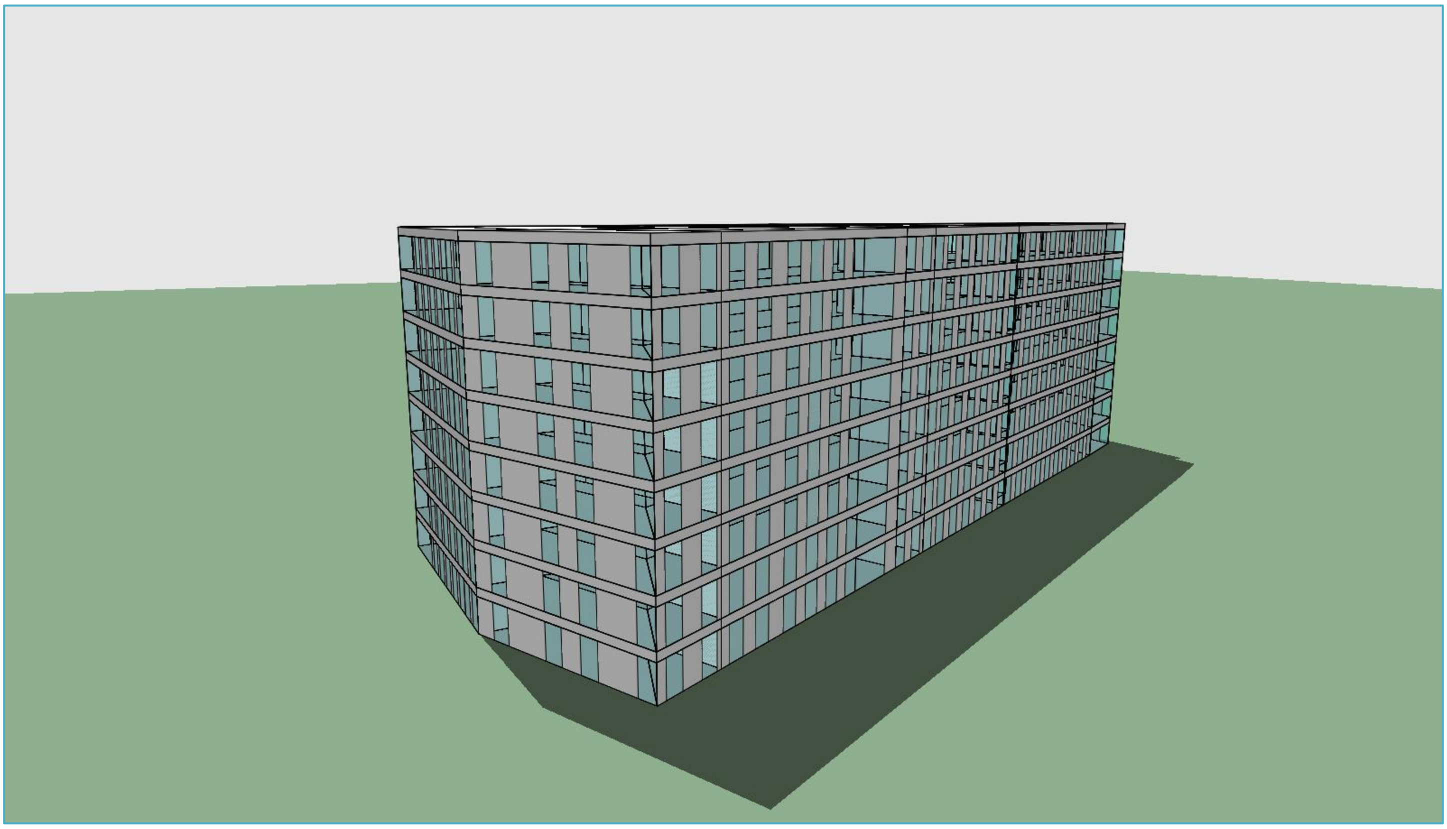
3.2 South West View



3.3 South East View



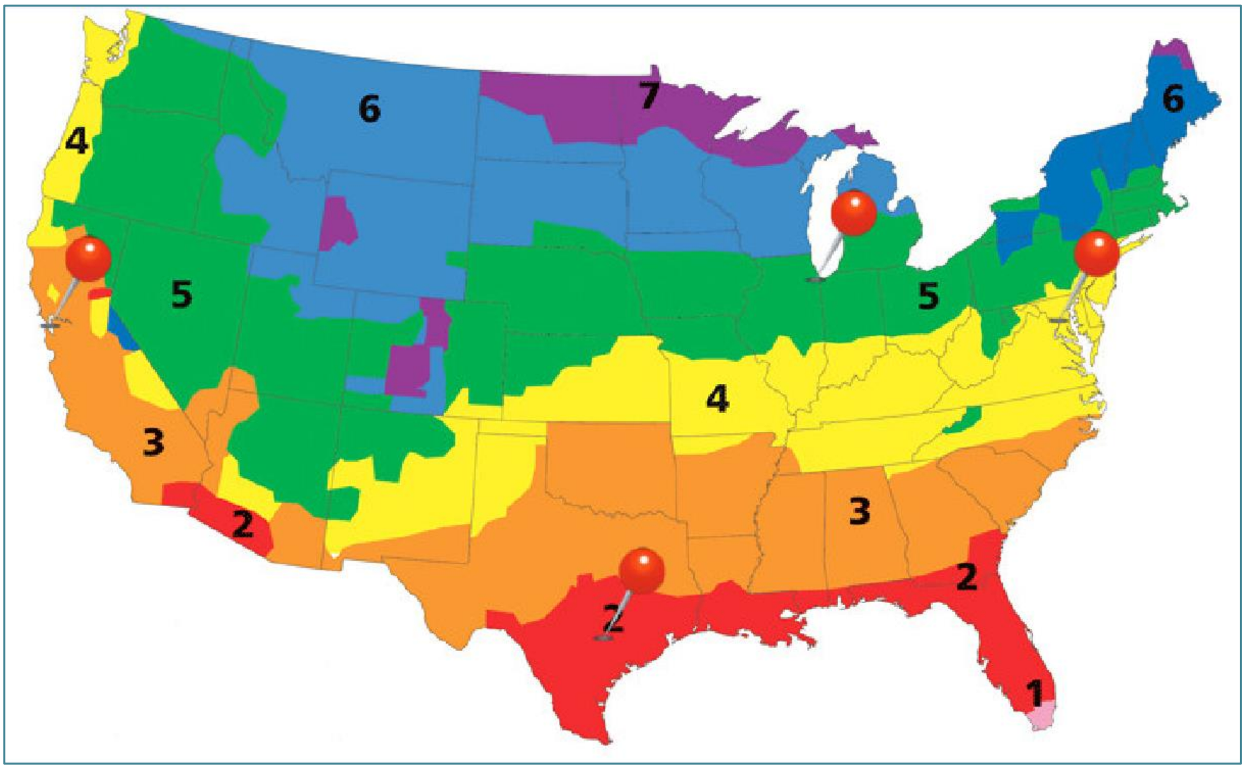
3.4 North East View



4 Locations

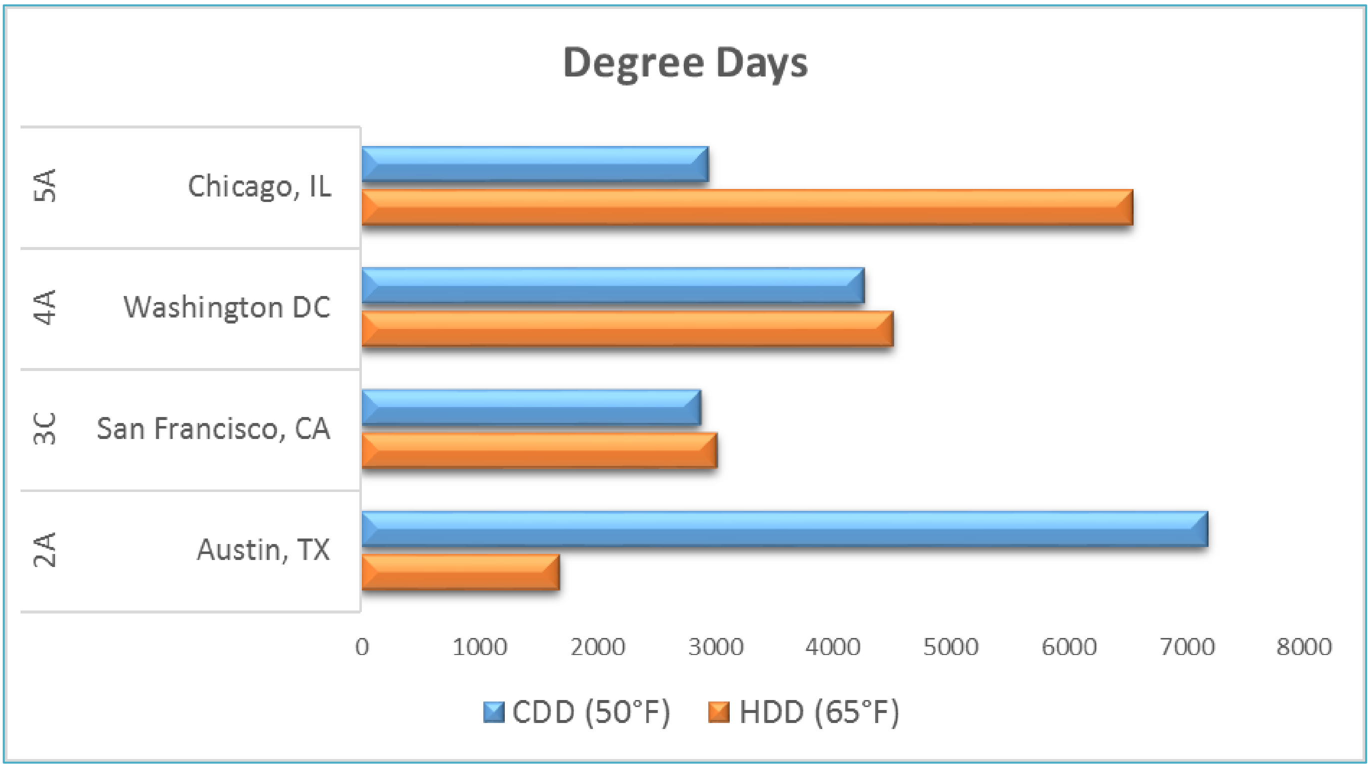
The analysis was implemented for multiple locations to demonstrate how climate impacts the performance of the automated shade system. Four locations were selected to represent a range of climate zones; Austin TX, San Francisco CA, Washington DC and Chicago IL.

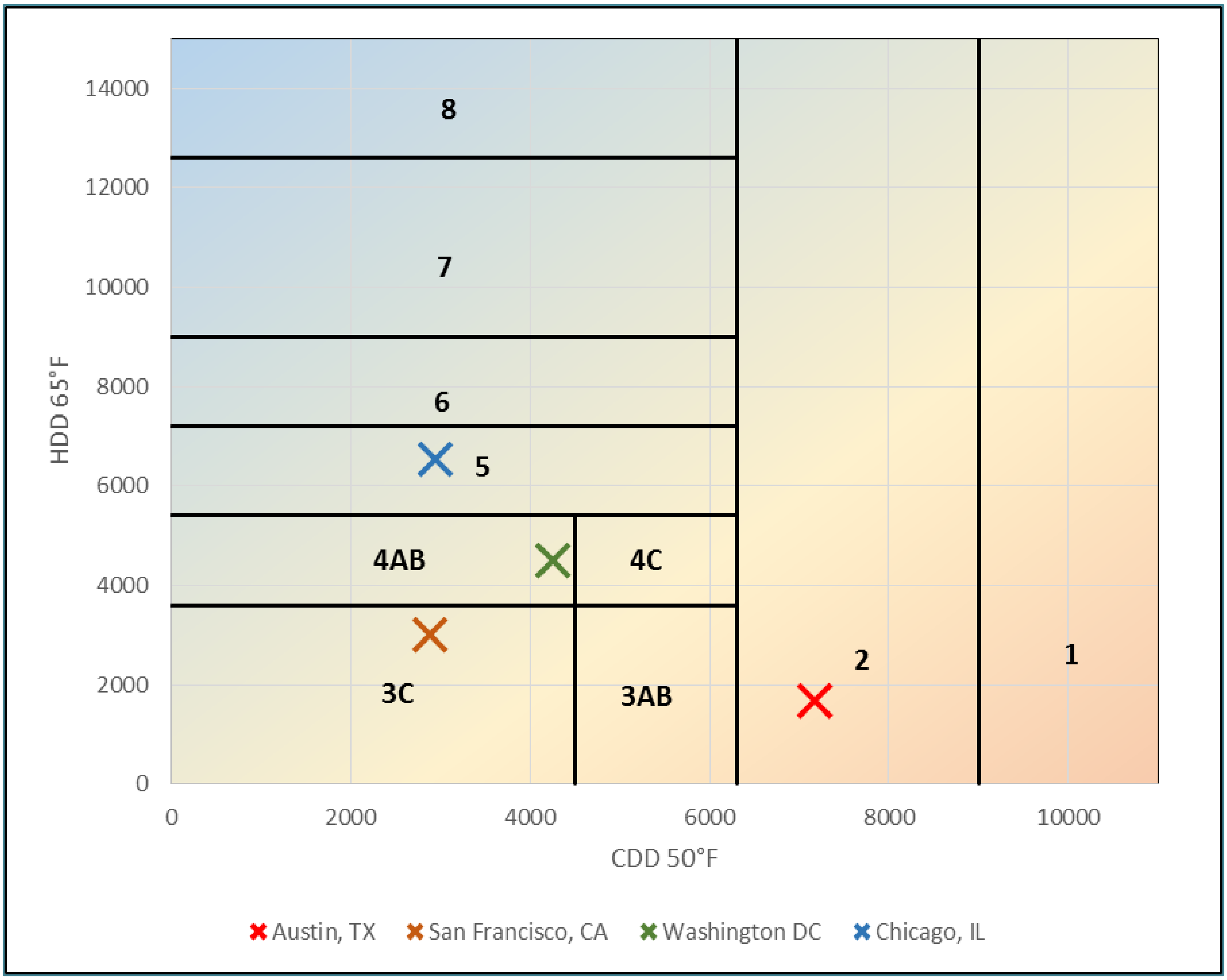
The map below shows their locations and designated ASHRAE climate zone. These zones range from 1 to 8 and are defined as 1 being the hottest and 8 being the coldest, with the vast majority of the contiguous United States falling into zones 2 to 6.



Characteristics regarding the climate for these locations are detailed for each site through heating degree days (HDD) and cooling degree days (CDD), and also the heating and cooling design conditions.

Climate Zone	City	HDD (65°F)	CDD (50°F)	Heating Design Temperature (°F)	Cooling Design Temperature Dry Bulb (°F)	Cooling Design Temperature Wet Bulb (°F)
2A (Hot-Humid)	Austin, TX	1688	7171	27	101	75
3C (Warm-Marine)	San Francisco, CA	3016	2883	39	84	64
4A (Mixed-Humid)	Washington DC	4511	4259	16	97	76
5A (Cool-Humid)	Chicago, IL	6536	2941	0	95	77


Degree Days
5A Chicago, IL
4A Washington DC
3C San Francisco, CA
2A Austin, TX
0 1000 2000 3000 4000 5000 6000 7000 8000
CDD (50°F)
HDD (65°F)


HDD 65°F
CDD 50°F
14000
12000
10000
8000
6000
4000
2000
0
0 2000 4000 6000 8000 10000
8
7
6
5
4AB
4C
3C
3AB
2
1
Austin, TX
San Francisco, CA
Washington DC
Chicago, IL

5 Constructions

The key difference between the models lies in the glazing performance. In one case the model incorporates a high performance solar control glass. This model does not include any shade control and as such the properties of the glazing system is static. The properties for this high performance glass unit are based on a Viracon VUE 1-50 product.

The comparison model is equipped with a low emissivity glass with an automated internal shade. The characteristics of this shade control are documented in section 5 of the report. Depending on the position of the shade the performance of the glass will be variable. The construction properties for this construction are based on a Viracon VE1-2M glazing installation with a Verosol Silverscreen 205 ED 03 shade.

5.1 Glass Analysis

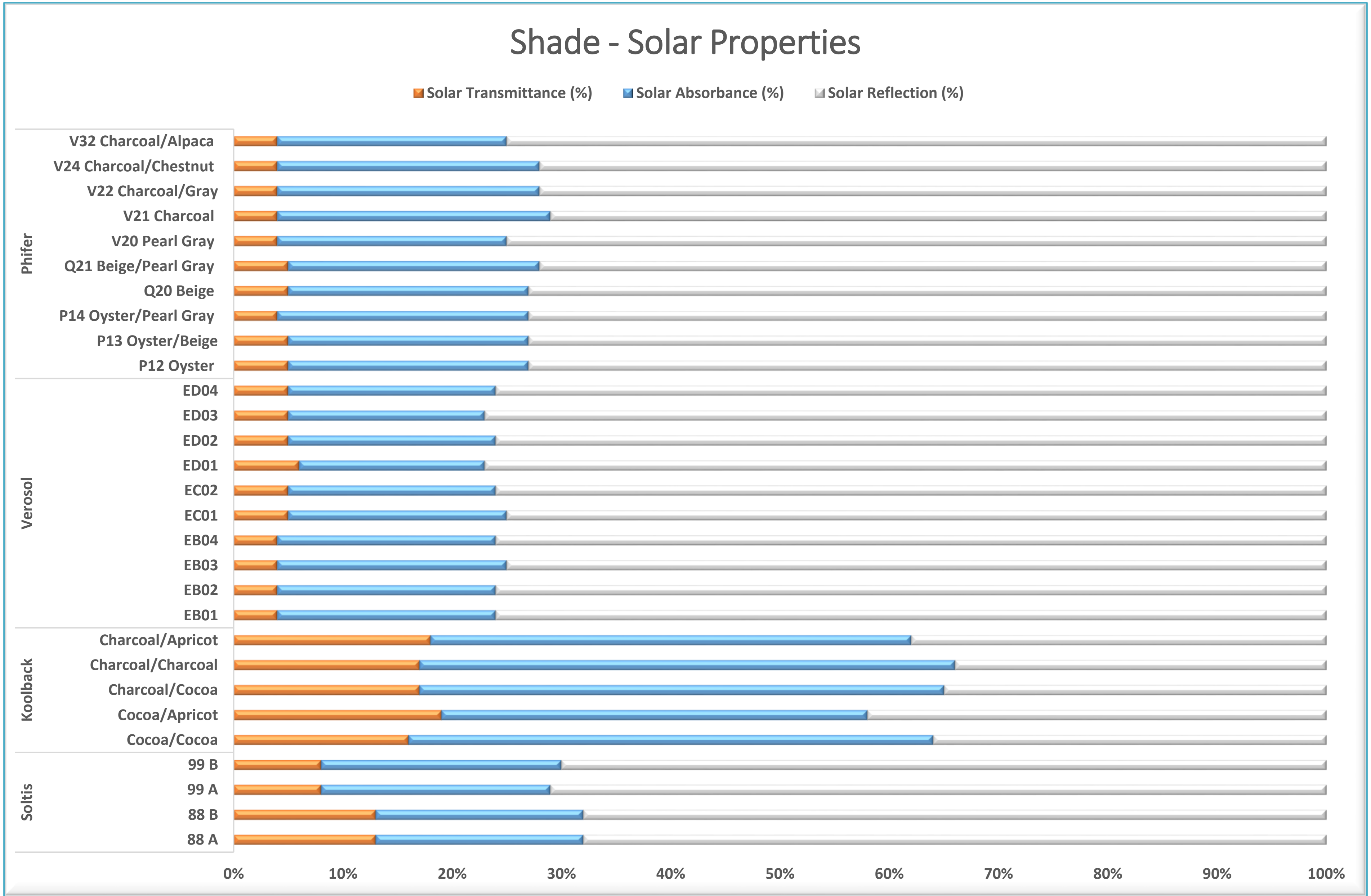
The table below summarizes the glass performance characteristics as calculated using *Berkeley Lab WINDOW*.

Location	Glass Property	With Automated Shade	Without Automated Shade
Austin & San Francisco	Name	Viracon VUE 1-50	Viracon VUE 1-50
	U-Value	0.237	0.237
	SHGC	0.245	0.245
	Light Transmittance	48%	48%
	Light Transmittance with Shade	3%	N/A
Chicago & Washington DC	Name	Viracon VE 1-2M	Viracon VE 1-2M
	U-Value	0.239	0.239
	SHGC	0.358	0.358
	Light Transmittance	70%	70%
	Light Transmittance with Shade	4.20%	N/A

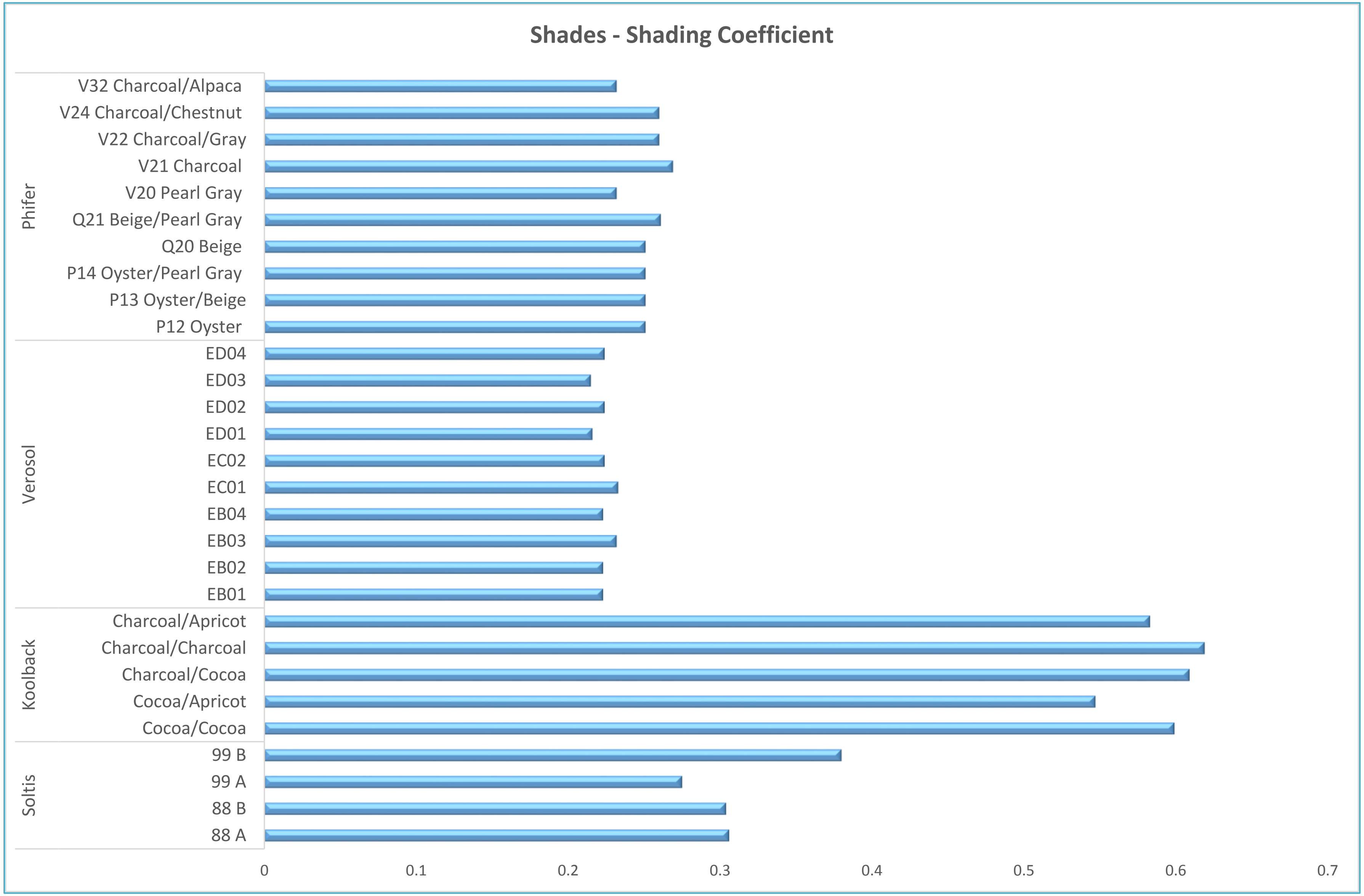
5.2 Shade Material Analysis

A range of shade options were assessed for their suitability to optimize the design. Based on this comparison it was determined that the Verosol product offered the most appropriate shading performance largely due to its increased reflective properties.

Optical performance is split into three properties; transmittance, reflectance and absorbance. The chart on the following page compares these properties for each of the shades assessed. The majority of the products are dominated by their high reflectance component which in turn means a low solar transmittance to the space behind but also a low solar absorbance which will assist in reducing radiative and conductive gains into the space. The reflective component will perform best for external shades as when located internally the solar energy has already entered the building and the reflected energy will instead be absorbed by the glazed unit.

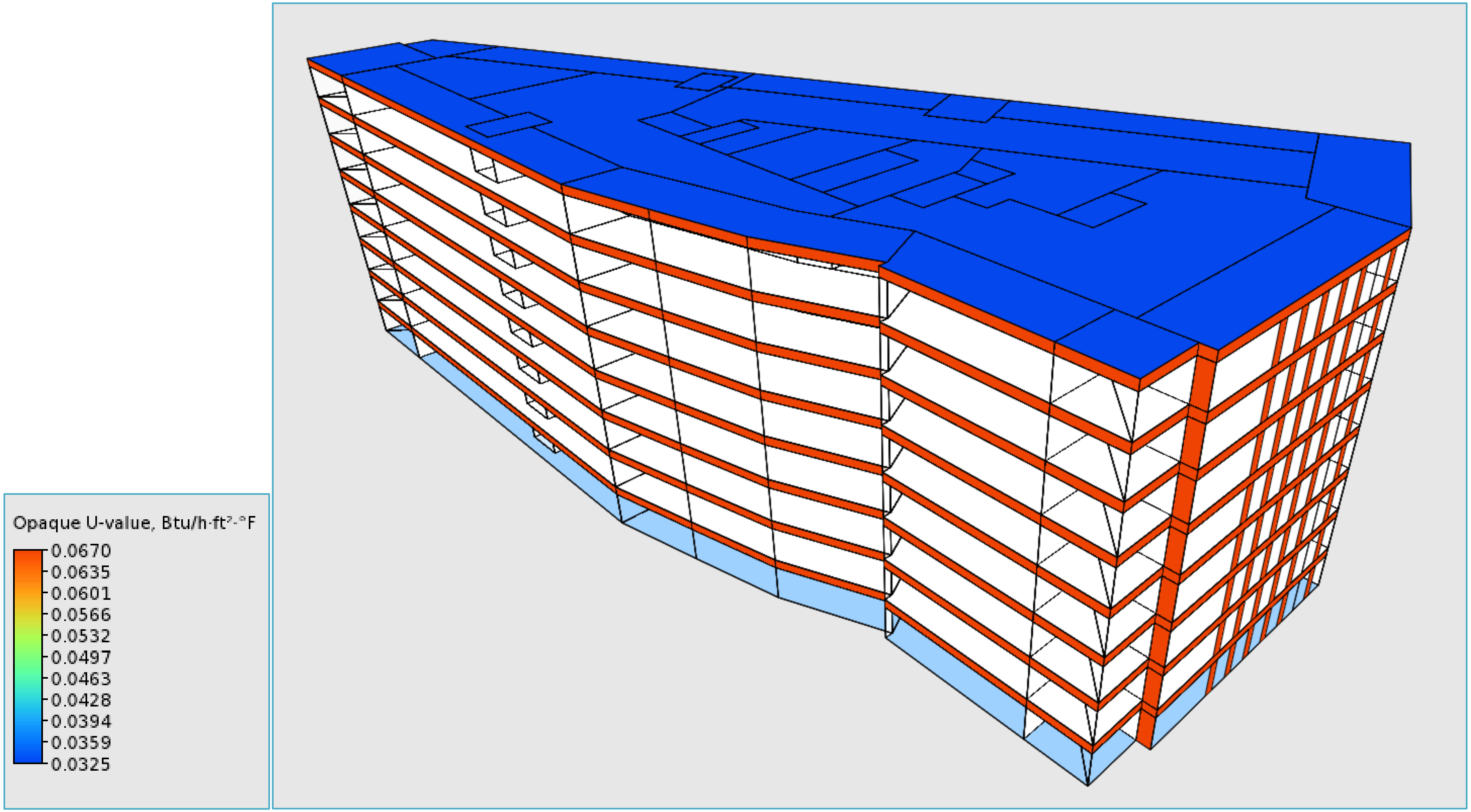

Shade - Solar Properties
Solar Transmittance (%)
Solar Absorbance (%)
Solar Reflection (%)
Phifer
V32 Charcoal/Alpaca
V24 Charcoal/Chestnut
V22 Charcoal/Gray
V21 Charcoal
V20 Pearl Gray
Q21 Beige/Pearl Gray
Q20 Beige
P14 Oyster/Pearl Gray
P13 Oyster/Beige
P12 Oyster
Verosol
ED04
ED03
ED02
ED01
EC02
EC01
EB04
EB03
EB02
EB01
Koolback
Charcoal/Apricot
Charcoal/Charcoal
Charcoal/Cocoa
Cocoa/Apricot
Cocoa/Cocoa
Soltis
99 B
99 A
88 B
88 A
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%

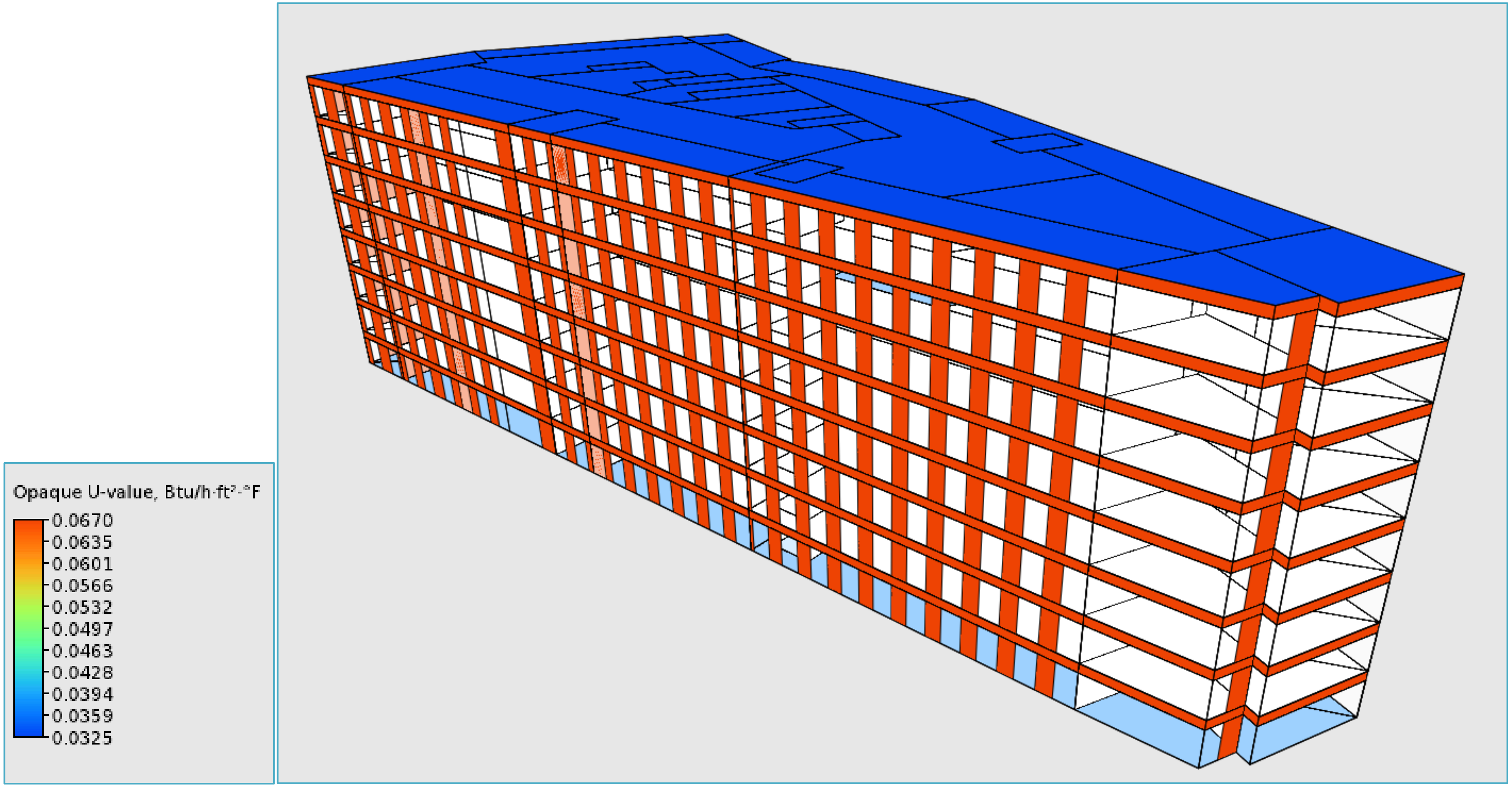
The chart below demonstrates the calculated shading co-efficient that each shade offered. The lower values represent a lower proportion of solar energy passing through the shade subsequently resulting in lower cooling loads.



5.3 Construction U-Values

The following images illustrate the assigned U-values across the external opaque construction elements.




Opaque U-value, Btu/h·ft²·°F
0.0670
0.0635
0.0601
0.0566
0.0532
0.0497
0.0463
0.0428
0.0394
0.0359
0.0325

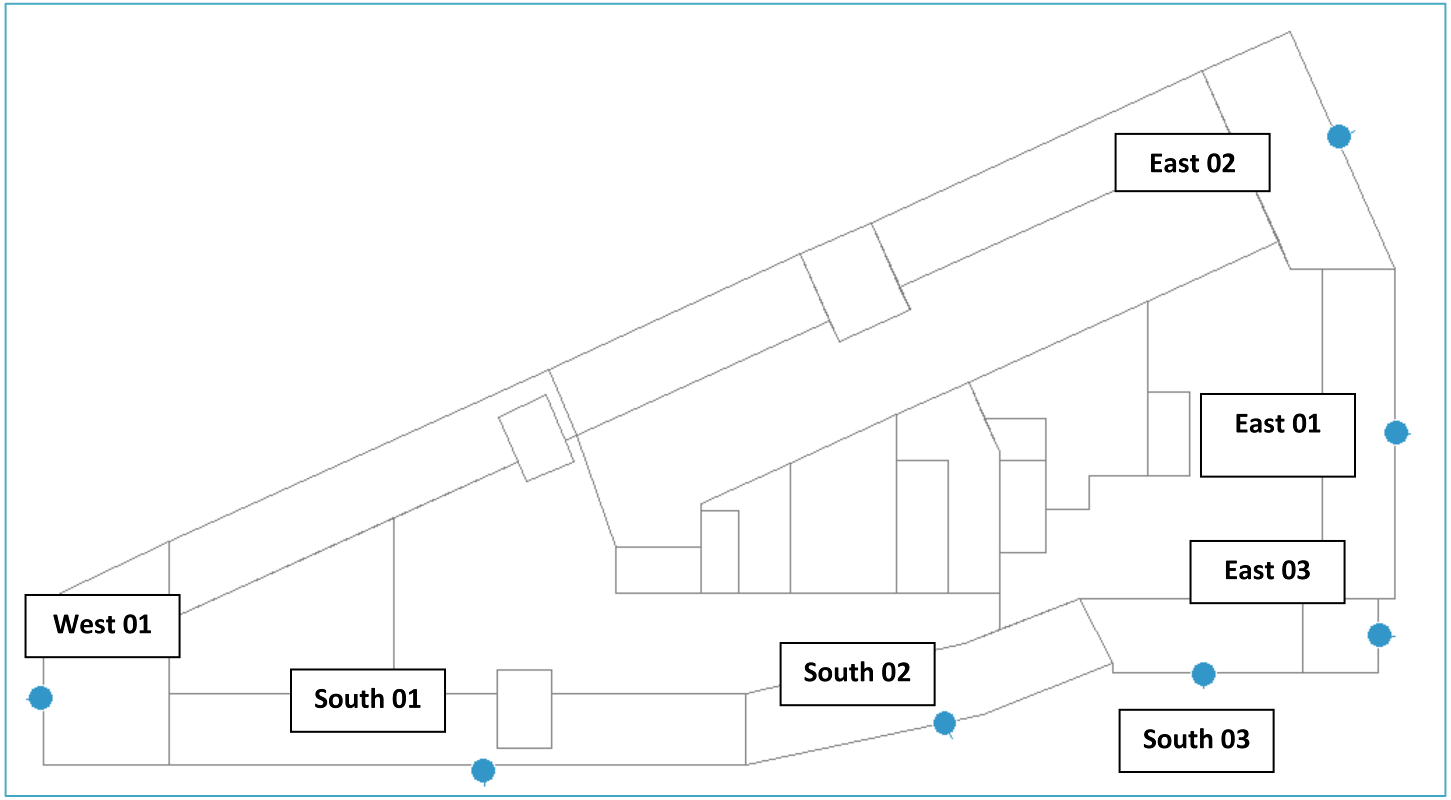
6 Shade Control Methodology

6.1 External Illuminance Sensors

The model has been configured to represent the solar penetration control applied by Somfy. With this control strategy, once there is a signal for the shade to operate then the shade will lower into a position where solar penetration is limited to 1m (3.28 feet). The level of closure is determined by the solar altitude at that time.

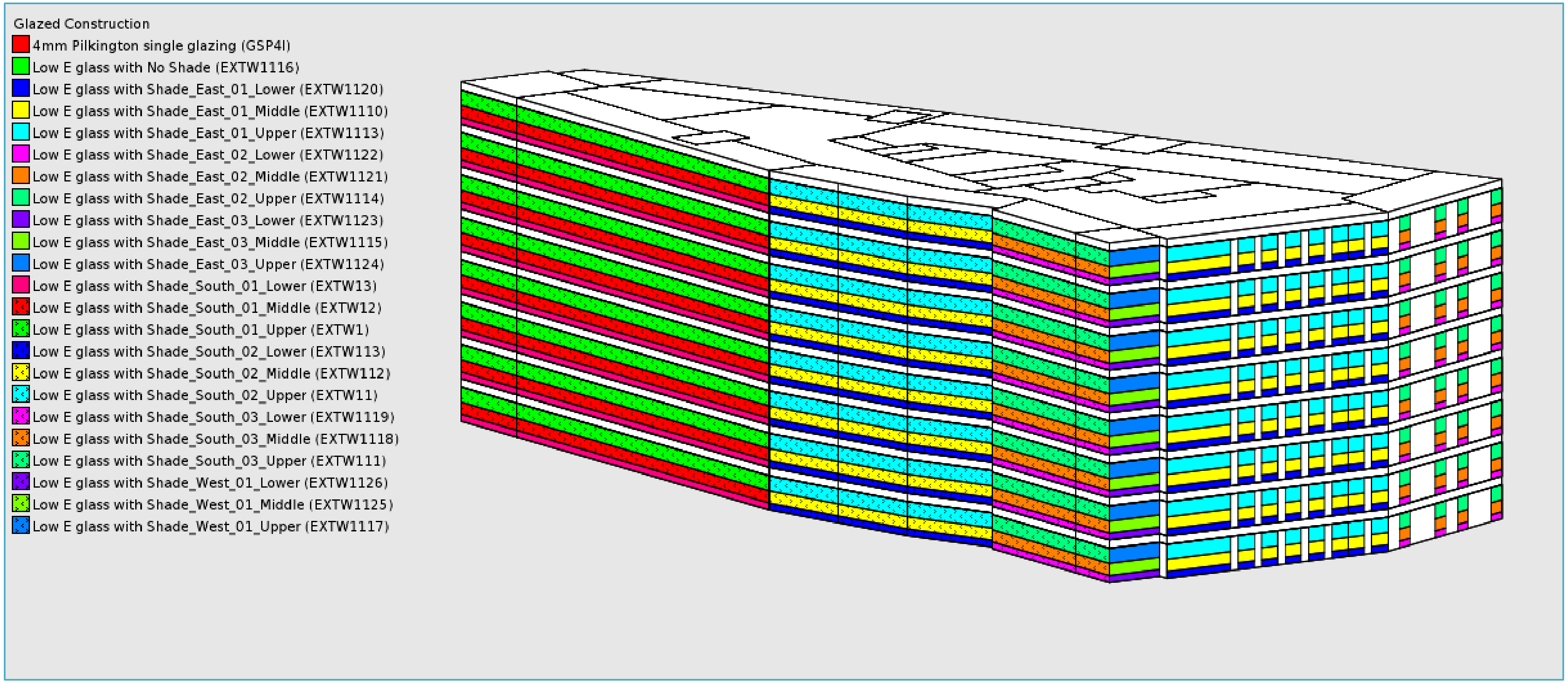
The shades are controlled based on readings from an external illuminance sensor. When an upper illuminance threshold is of 25,000 lux reached the shades are closed. The shades re-open once the illuminance drops below a lower threshold of 15,000 lux.

In total 7 separate external illuminance sensors have been defined and positioned perpendicular to the façade to define the shade control.



6.2 Shade Control Assignment

Each shade is controlled by a linked external illuminance senor based on the façade orientation. The image below shows this assignment and their connection to the sensors shown above.



6.3 Night Time Shade Control

Operating the shades during the night can assist in reducing heating loads by adding a further layer of resistance to the glazing unit. The benefit is more profound in the colder climate zones. The control can be scheduled within the energy model to operate when the solar altitude drops to 0° (i.e. the sun has set). This approach allows the varying length of day throughout the year to be represented.

7 Thermal Templates

The table shown below lists the thermal templates assigned within the model to represent the typical space types. The templates summarize the internal gains and set points applied for each of the activity types.

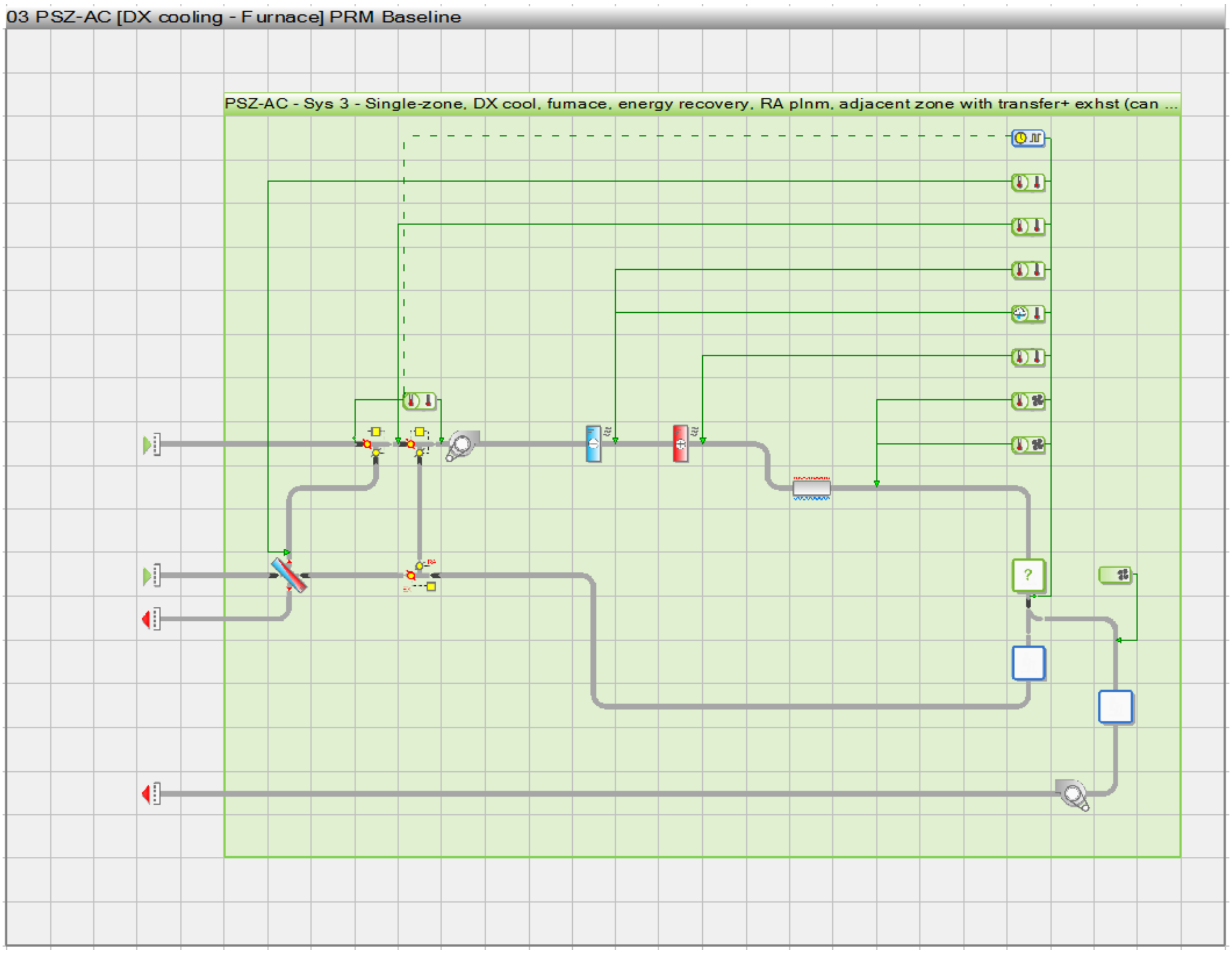
Thermal Template	Lighting Power Density W/ft^2	Occupancy Density ft^2/person	Equipment Power Density W/ft^2	Heating Setpoint °F	Cooling Setpoint °F
SPACE: Conference / Meeting / Multipurpose	1.3	50	1	70	75
SPACE: Corridor / Transition	0.5	-	0.2	70	75
SPACE: Electrical / Mechanical	1.5	-	0.2	70	75
SPACE: IDF Room	-	-	5	70	75
SPACE: Office - Open Plan	1.1	150	1.5	70	75
SPACE: Restrooms	0.9	-	0.5	70	75
SPACE: Stairs - Active	0.6	-	1	-	-
SPACE: Void / Plenum	-	-	-	-	-

7.1 Air Permeability

The model is configured to represent the building’s air permeability through an infiltration rate of 0.1 air changes per hour (ACH).

9.2 System 3 – Packaged Single Zone Air Conditioner

The screenshot below shows a typical representation of a Packaged Single Zone system which will serve each of the IDF rooms.



10 Results

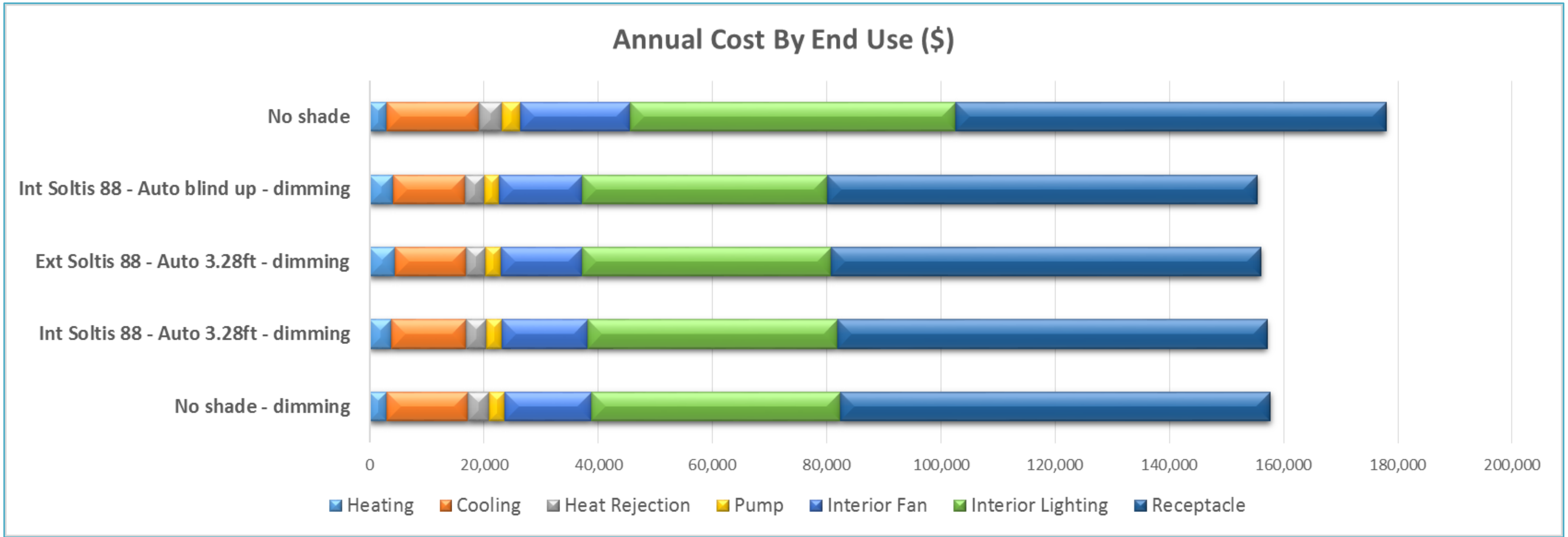
10.1 San Francisco, California

10.1.1 Optimum Solution

The relatively mild climate in San Francisco required the optimum solution to consider lighting as the largest regulated energy end use due to the relatively small requirements of heating and cooling. Consequently an optimization strategy to enhance light penetration and daylighting savings to reduce the lighting load while still providing improved visual comfort through glare mitigation was necessary.

Fine tuning the model maintained some improvement in cooling energy and minimized the heating energy increase. This was possible by using an insulating glass unit with a high visible light transmittance and a shade up internal shade with solar adaptive control, also adding in daylight sensors to dim the electric lighting while maintaining visual comfort (reducing glare).

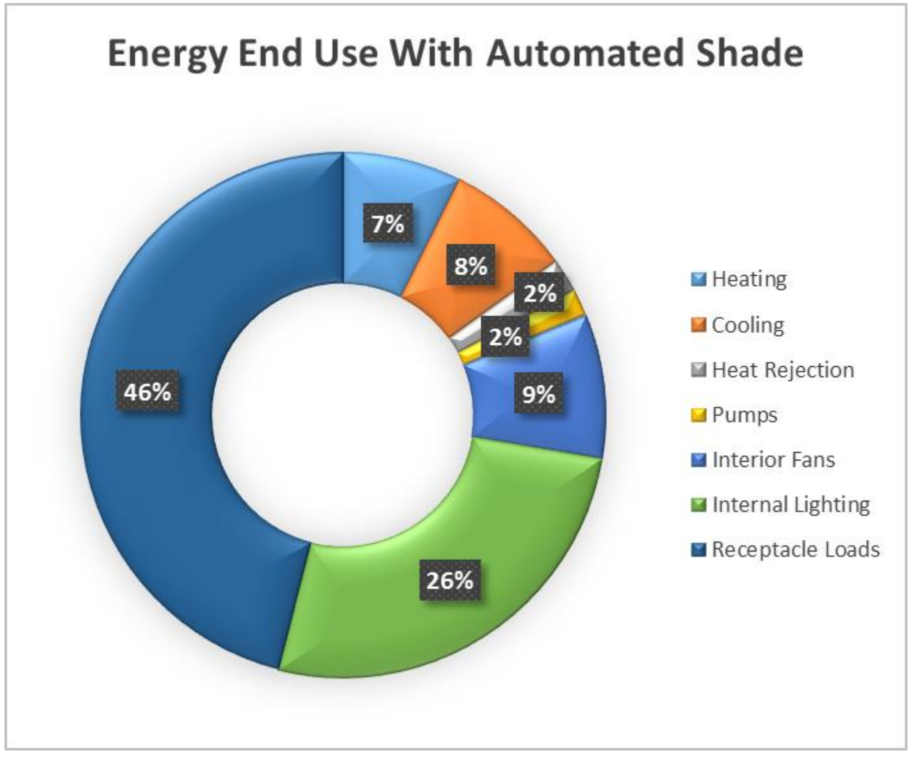
The optimal solution contributes to Title 24 compliance and results in annual energy cost savings of approximately 2.7% and contributes to the previously listed 4 LEED credits.

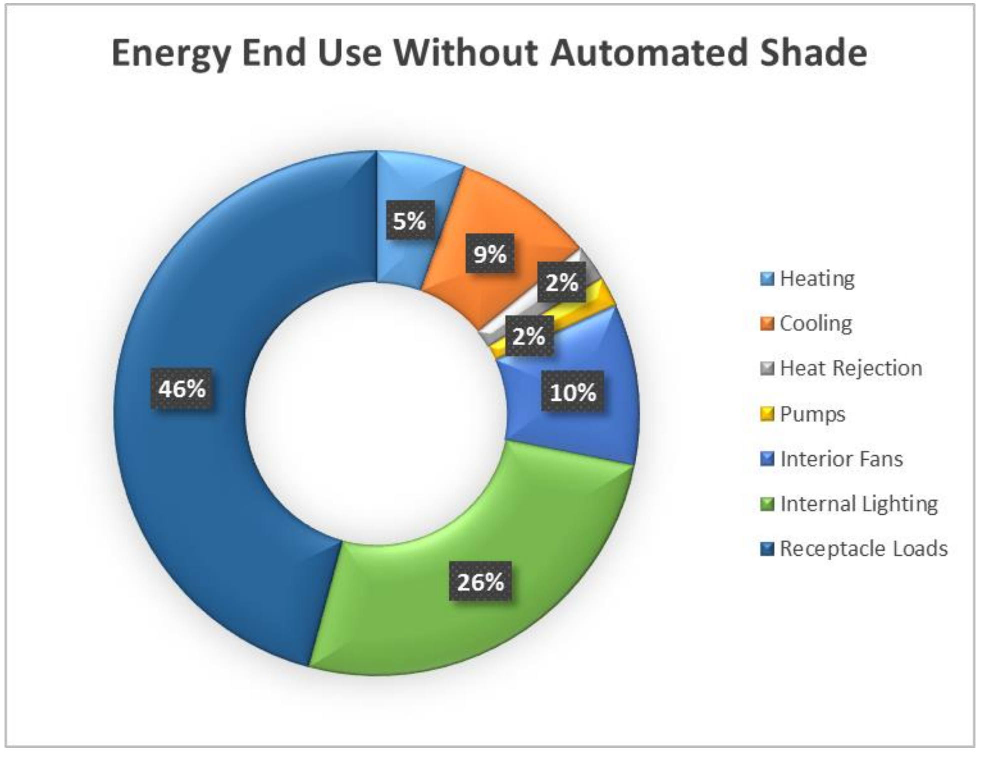


10.1.2 End Use Breakdown

The optimum solution when reviewing energy end use demonstrates lighting as the cost most influenced by the shade system, considerably greater than either heating or cooling in this instance.

Largest regulated energy use cost = Lighting - 26%





10.1.3 Thermal Comfort

The PMV thermal comfort report identified the automated shading system powered by Somfy would ensure comfort conditions throughout the year whether installed as either an internal or external shading system.

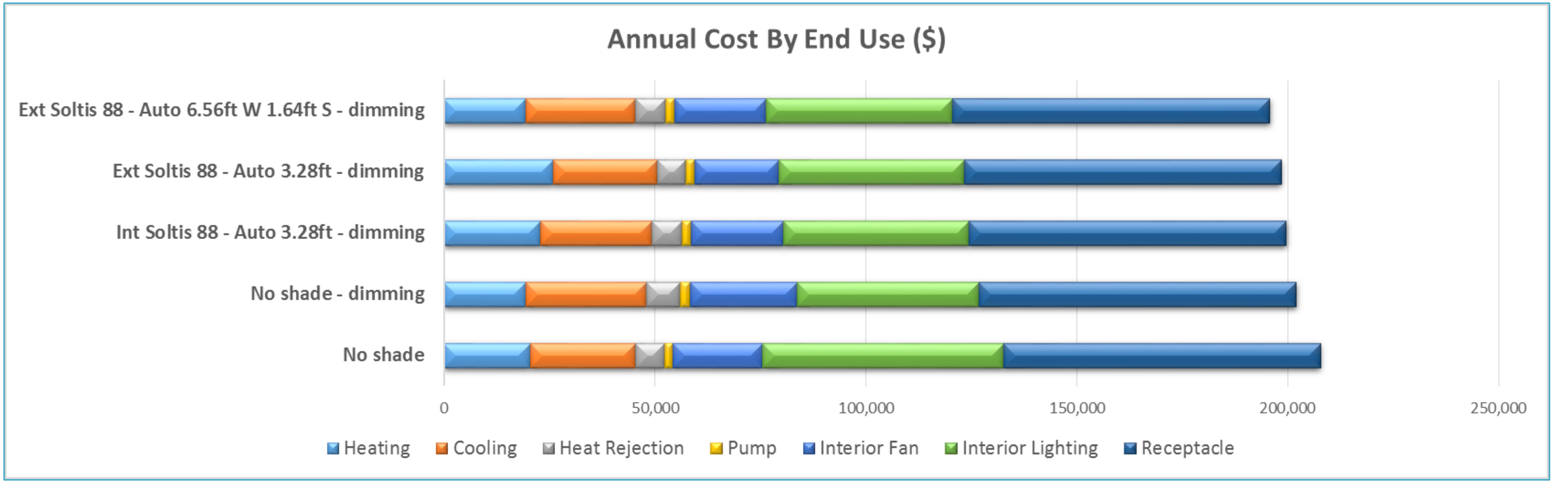
Orientation	Shade Position	Predicted mean vote - hours in range					
		> 0.10	> 0.20	> 0.30	> 0.40	> 0.50	> 0.60
South	External Shade	386	76	1	0	0	0
	Internal Shade	664	171	19	0	0	0
	No Shade	1072	572	240	63	5	0
East	External Shade	63	4	0	0	0	0
	Internal Shade	185	32	1	0	0	0
	No Shade	738	346	99	19	2	0
West	External Shade	119	11	0	0	0	0
	Internal Shade	218	41	2	0	0	0
	No Shade	539	255	54	2	0	0

10.2 Chicago, Illinois

10.2.1 Optimum Solution

In contrast to San Francisco, the heating energy usage for Chicago required the optimum solution to respond to heating and cooling seasons differently. It focused on a solution to maximize the winter heat gain by utilizing a high solar heat gain glazing and then mitigated that same heat gain in the summer cooling season by utilizing the automated shading system powered by Somfy. The exterior shading assisted in providing solar protection to the glazing in the summer and still allow beneficial solar gains in the winter to enter.

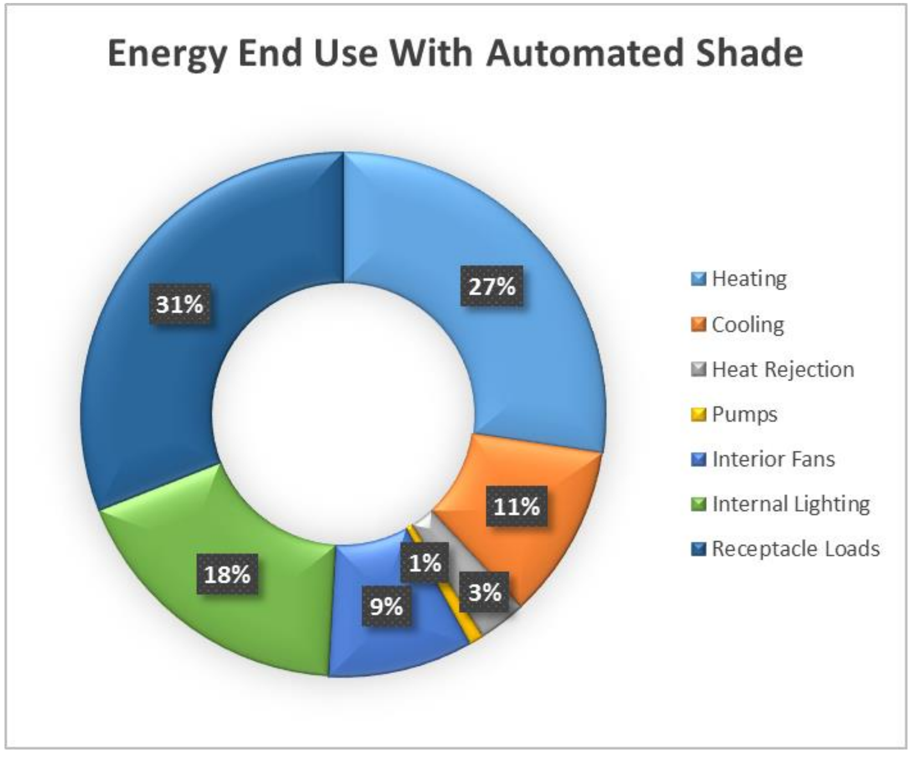
These characteristics were accomplish by utilizing external shades with an automatic winter and summer model control strategy to achieve approximately 5% annual utility cost savings and achieve 3 LEED credits.

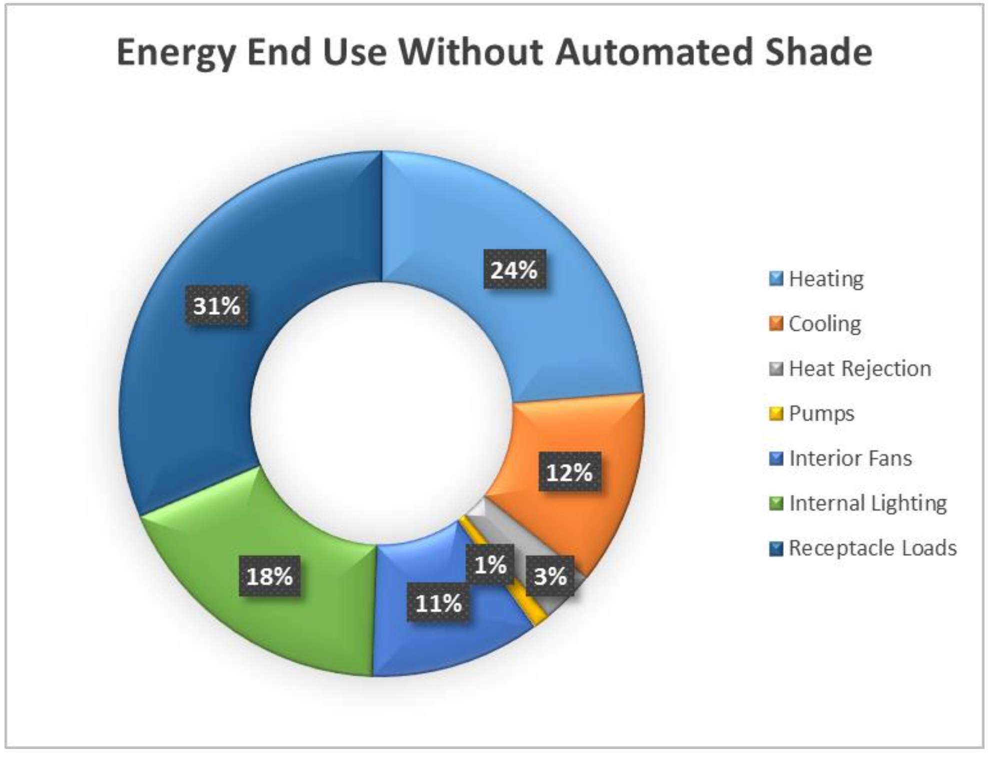


10.2.2 End Use Breakdown

The optimum solution when reviewing energy end use demonstrates heating as the cost most influenced by the shade system, considerably greater than lighting in this instance.

Largest regulated energy use = Heating - 27%





10.2.3 Thermal Comfort

The PMV thermal comfort report identified the automated shading system powered by Somfy would ensure comfort conditions throughout the year whether installed as either an internal or external shading system.

Orientation	Shade Position	Predicted mean vote - hours in range					
		> 0.10	> 0.20	> 0.30	> 0.40	> 0.50	> 0.60
South	External Shade	43	12	1	0	0	0
	Internal Shade	126	38	13	4	1	0
	No Shade	500	344	221	137	83	57
East	External Shade	0	0	0	0	0	0
	Internal Shade	22	6	0	0	0	0
	No Shade	189	117	69	33	14	6
West	External Shade	90	28	6	1	0	0
	Internal Shade	184	102	53	21	7	2
	No Shade	428	306	230	162	110	77

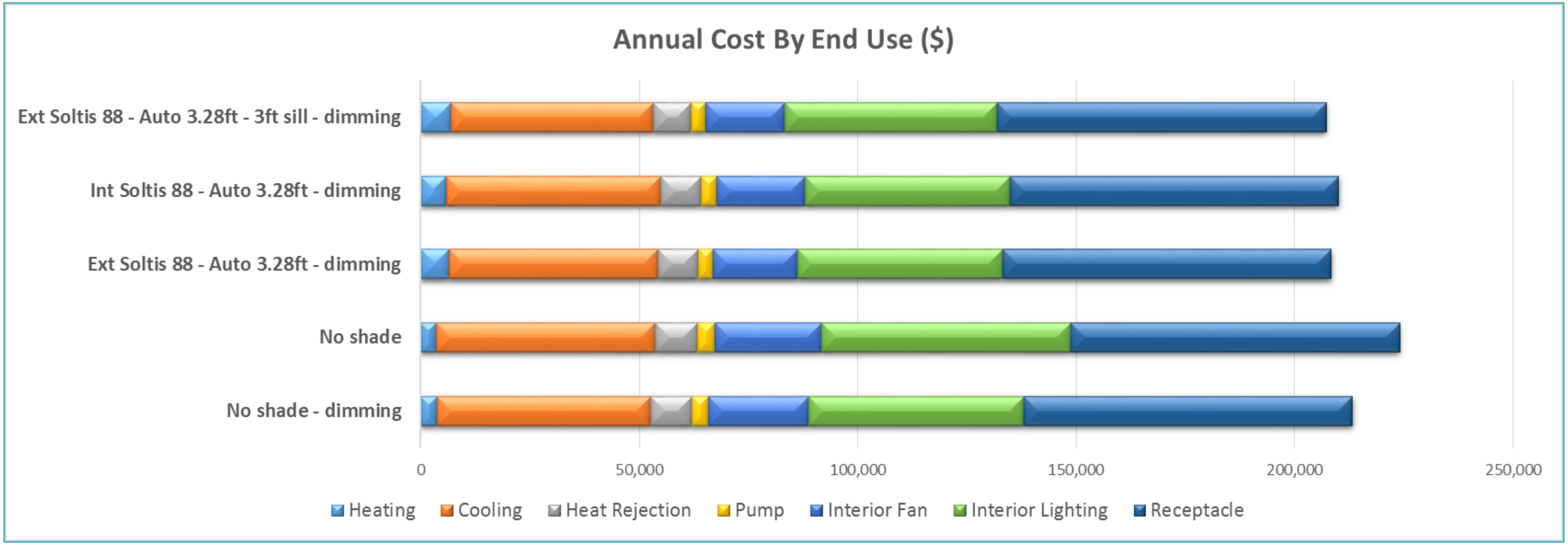
10.3 Austin, Texas

10.3.1 Optimum Solution

The third city chosen to study was the cooling dominated climate of Austin, Texas. In some ways this solution was the most straightforward in that it needed to minimize the solar heat gain (and glare) while maintaining optimum daylight penetration and energy savings by optimizing the daylight dimming control.

Positioning the shade external to the building envelope can assist in further reducing solar loads compared to positioning the shade inside. The size of the window can make a notable impact as well. Full height glazing can result in little useful daylight entering the zone at low level but can result in an increased solar load and cooling demand.

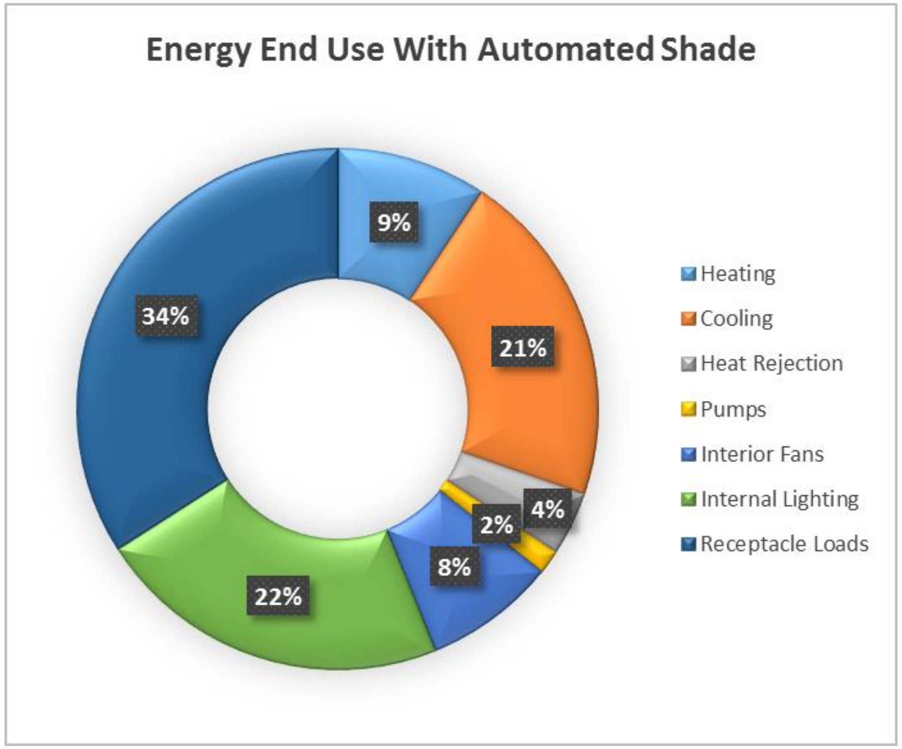
Our chosen solution utilized external top down shades and resulted in 7% annual energy savings and the solution also contributed to achieving 4 LEED Credits.

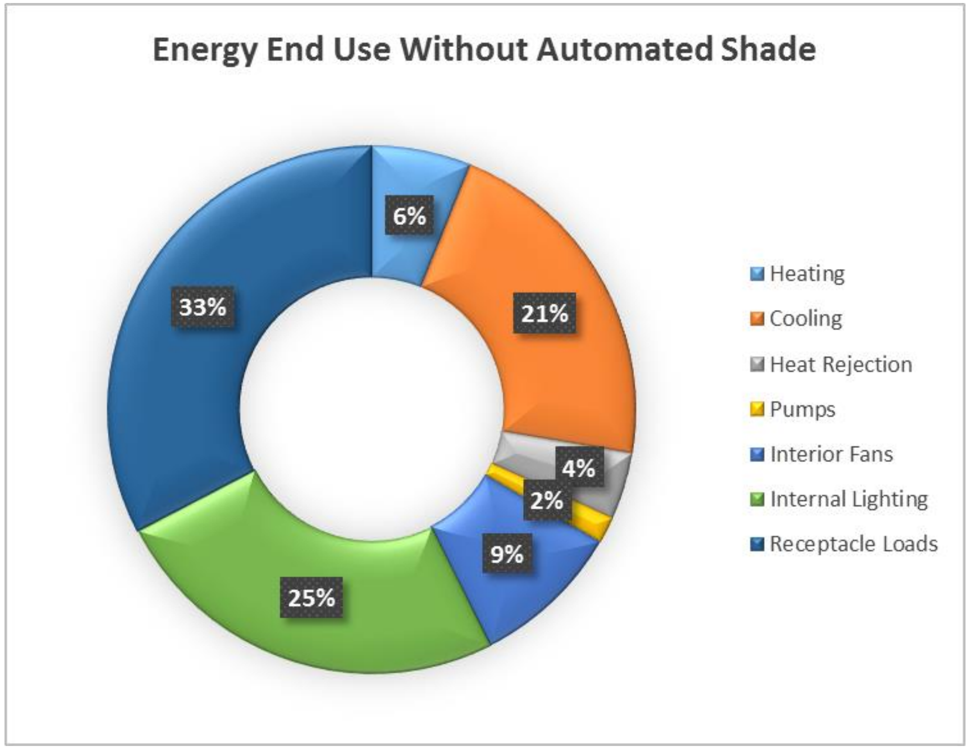


10.3.2 End Use Breakdown

The optimum solution when reviewing energy end use demonstrates lighting as the cost most influenced by the shade system, narrowly greater than cooling in this instance.

Largest regulated energy uses cost = Lighting - 22%, Cooling – 21%





10.3.3 Thermal Comfort

The PMV thermal comfort report identified the automated shading system powered by Somfy would ensure comfort conditions throughout the year whether installed as either an internal or external shading system.

Buildings that are highly glazed will often result in high mean radiant temperatures which can lead to occupant discomfort and the use of shades assists in mitigating this effect.

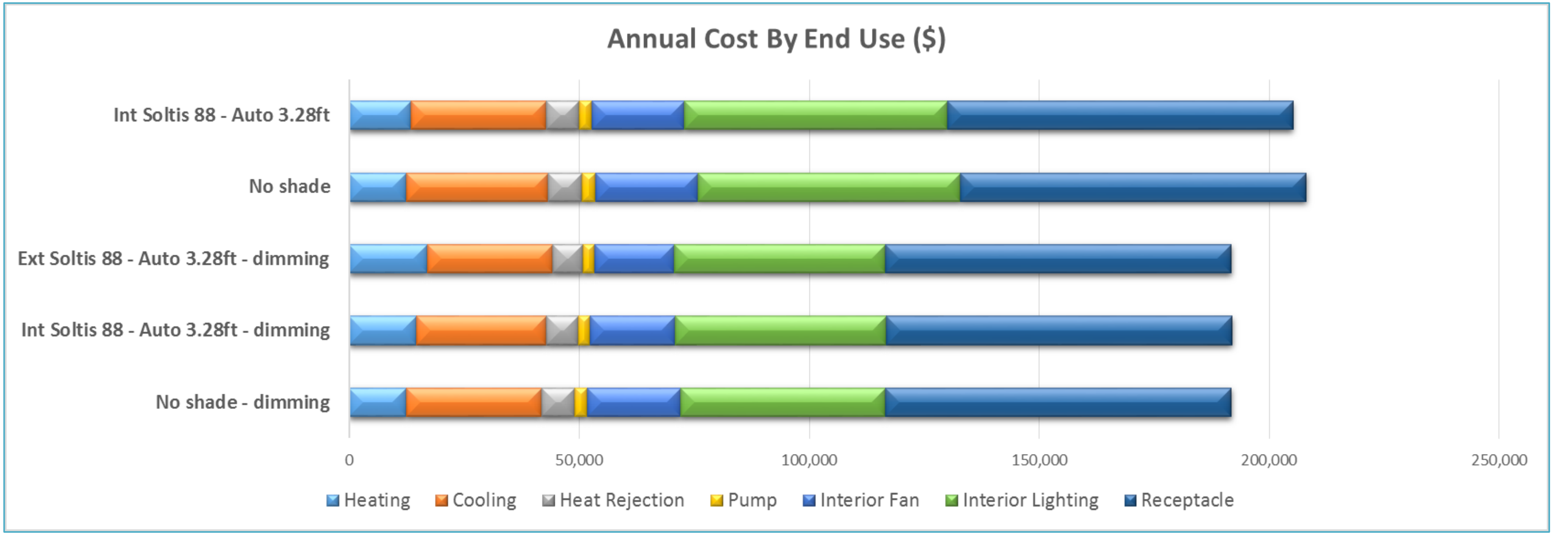
Orientation	Shade Position	Predicted mean vote - hours in range					
		> 0.10	> 0.20	> 0.30	> 0.40	> 0.50	> 0.60
South	External Shade	1187	728	219	14	0	0
	Internal Shade	1257	854	359	42	0	0
	No Shade	1532	1124	597	210	38	6
East	External Shade	1048	601	167	15	0	0
	Internal Shade	1087	677	272	44	0	0
	No Shade	1188	806	450	186	60	6
West	External Shade	774	402	128	7	0	0
	Internal Shade	878	523	207	30	0	0
	No Shade	1041	717	330	94	4	0

10.4 Washington, D.C.

10.4.1 Optimum Solution

Similar to San Francisco study, Washington, D.C. is a climate zone which has a balanced number of degree days in the heating and cooling seasons. Unlike San Francisco the peaks of both are higher and consequently the optimal solution needed to address both operating modes differed. The energy balance was similar in performance to a no shade solution however that scenario would have no contingency for visual comfort and protecting from occupants from potential glare.

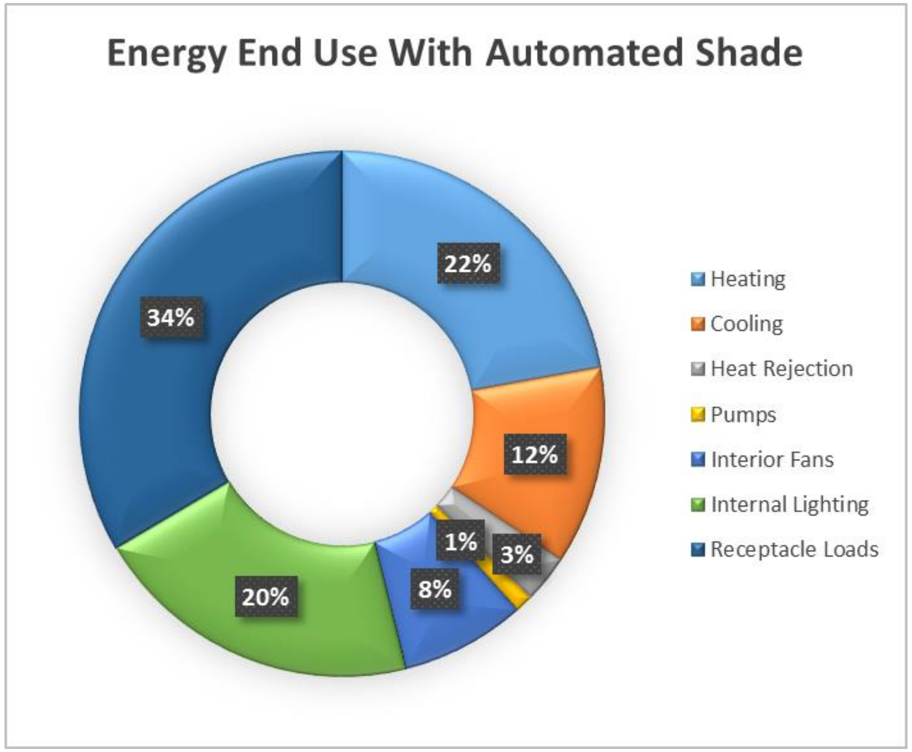
Our chosen solution utilized external automated top down shades and resulted in 7% annual energy savings and this solution also contributed to achieving 4 LEED credits.

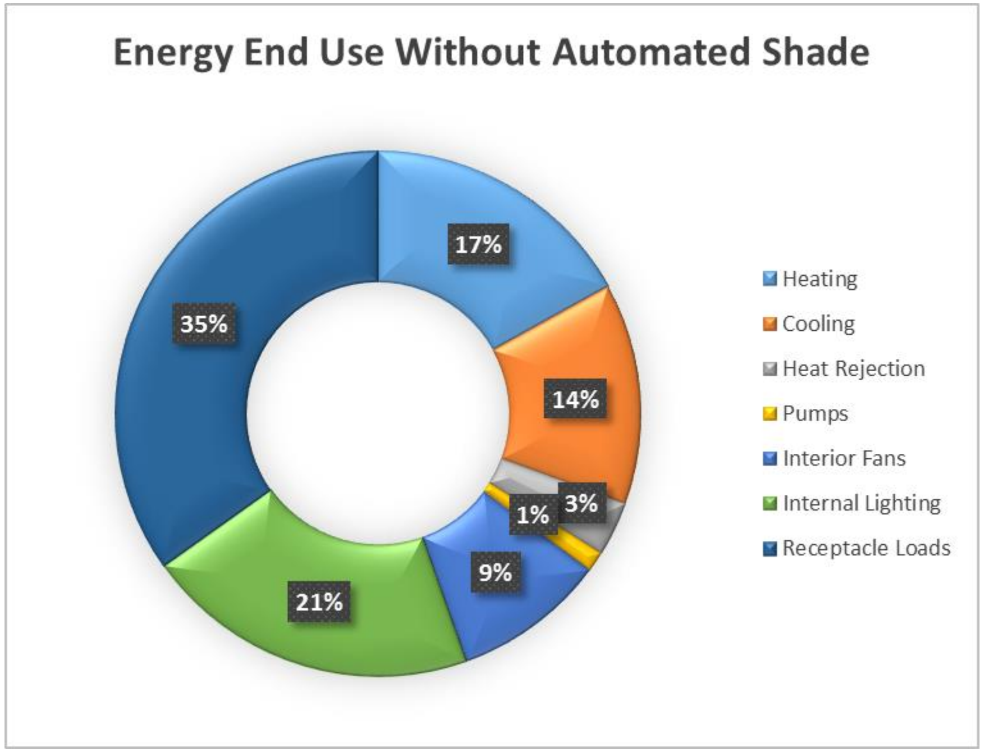


10.4.2 End Use Breakdown

The optimum solution when reviewing energy end use demonstrates heating as the cost most influenced by the shade system, narrowly greater than lighting in this instance.

Largest regulated energy uses = Heating – 22%, Lighting - 20%





10.4.3 Thermal Comfort

The PMV thermal comfort report identified the automated shading system powered by Somfy would ensure comfort conditions throughout the year whether installed as either an internal or external shading system.

Orientation	Shade Position	Predicted mean vote - hours in range					
		> 0.10	> 0.20	> 0.30	> 0.40	> 0.50	> 0.60
South	External Shade	144	14	1	0	0	0
	Internal Shade	195	30	1	0	0	0
	No Shade	448	177	56	7	0	0
East	External Shade	58	7	0	0	0	0
	Internal Shade	144	34	8	0	0	0
	No Shade	335	177	81	25	6	2
West	External Shade	159	44	6	1	0	0
	Internal Shade	241	87	21	3	0	0
	No Shade	447	238	118	52	14	1

11 Conclusion

The primary conclusions of this study are the automated shading systems powered by Somfy can be an effective strategy toward improving building performance most buildings across energy efficiency, thermal comfort and visual comfort.

It has also determined that finding the optimum solution(s) require detailed option analysis and an integrated approach which considers a collection of additional factors including:

- Architectural building form
- The building's function
- The local climate zone
- Glass selection
- Artificial lighting and associated daylight dimming controls
- The shading material choices
- Shading locations and control strategies

The use of building simulation which considers this range of factors into the energy calculation are critical to providing the appropriate conscious balance to achieve a high performance result that is appropriate to the owner and occupant requirements for the building in question.

For each location or climate zone the behavioural characteristics have been demonstrated and these can be used to develop likely options for further study in specific buildings.

12 Glossary

Degree Days
Heating degree day (HDD) is a measurement designed to measure the demand for energy needed to heat a building. HDD is derived from measurements of outside air temperature. The heating requirements for a given building at a specific location are considered to be directly proportional to the number of HDD at that location. A similar measurement, cooling degree day (CDD), reflects the amount of energy needed to cool.

Berkeley Lab WINDOW
https://windows.lbl.gov/software/window/window.html

ASHRAE 90.1 2007 Appendix G
A benchmark modelling process for commercial building energy codes in the United States and a key basis for codes and standards around the world.

ASHRAE 62.1
A code for recognized standards for ventilation system design and acceptable IAQ.

Visible Light Transmittance
The percentage of visible light that passes through a window or other glazing unit.

Solar Heat Gain Coefficient (SHGC)
The SHGC is the fraction of incident solar radiation admitted through a window, both directly transmitted and absorbed and subsequently released inward. SHGC is expressed as a number between 0 and 1. The lower a window's solar heat gain coefficient, the less solar heat it transmits.

Variable Air Volume (VAV)
A type of heating, ventilating, and/or air-conditioning (HVAC) system. Unlike constant air volume (CAV) systems, which supply a constant airflow at a variable temperature, VAV systems vary the airflow at a constant temperature.

Predicted Mean Vote (PMV)
The Predicted Mean Vote (PMV) refers to a thermal scale that runs from Cold (-3) to Hot (+3), originally developed by Fanger and later adopted as an ISO standard. The recommended acceptable PMV range for thermal comfort from ASHRAE 55 is between -0.5 and +0.5 for an interior space.

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