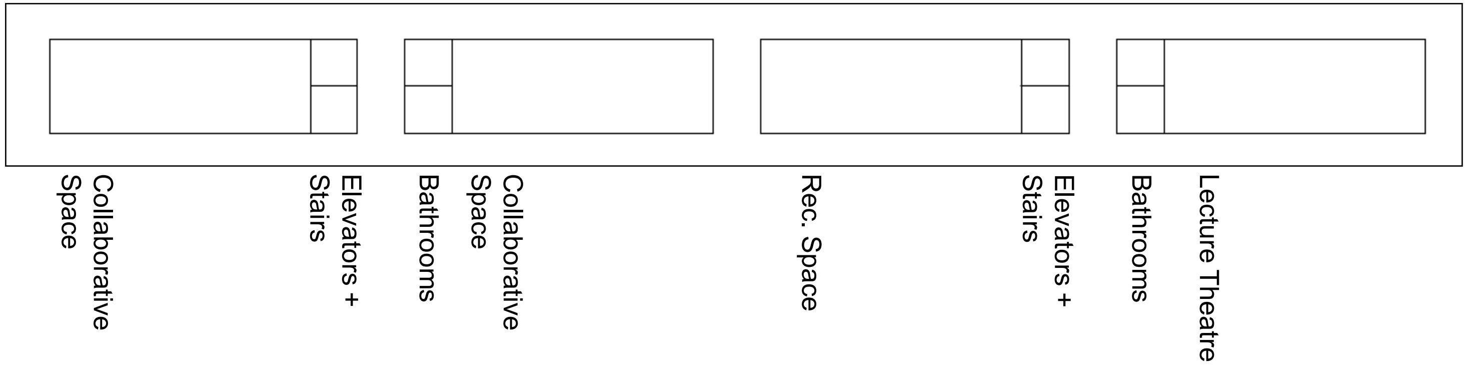
Large Scale Building Project - Singapore

Kehl Jones – n1120324

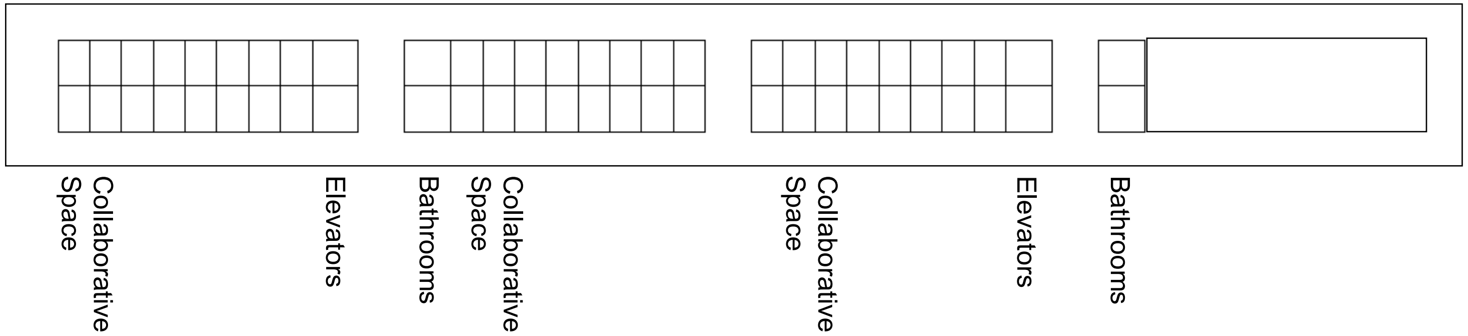
Site Plan

Primary Floorplans
Plans

Ground Floor

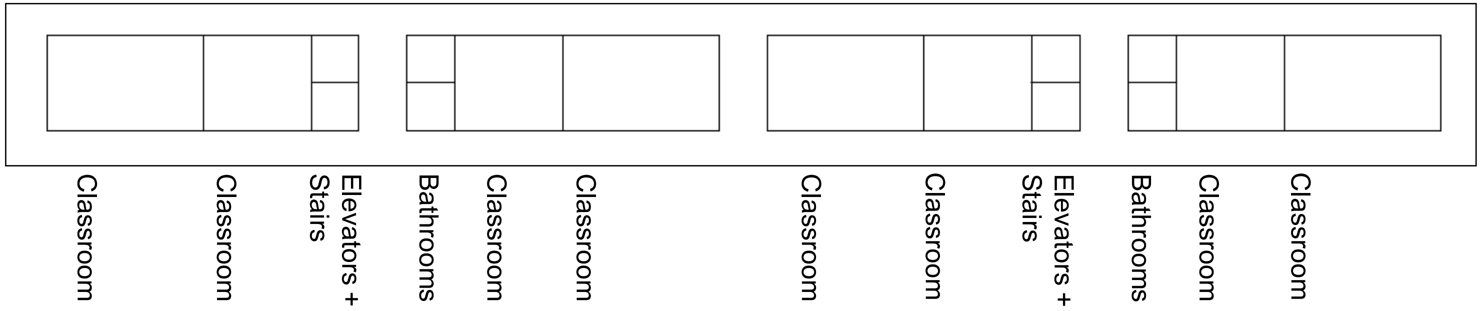


1st Floor

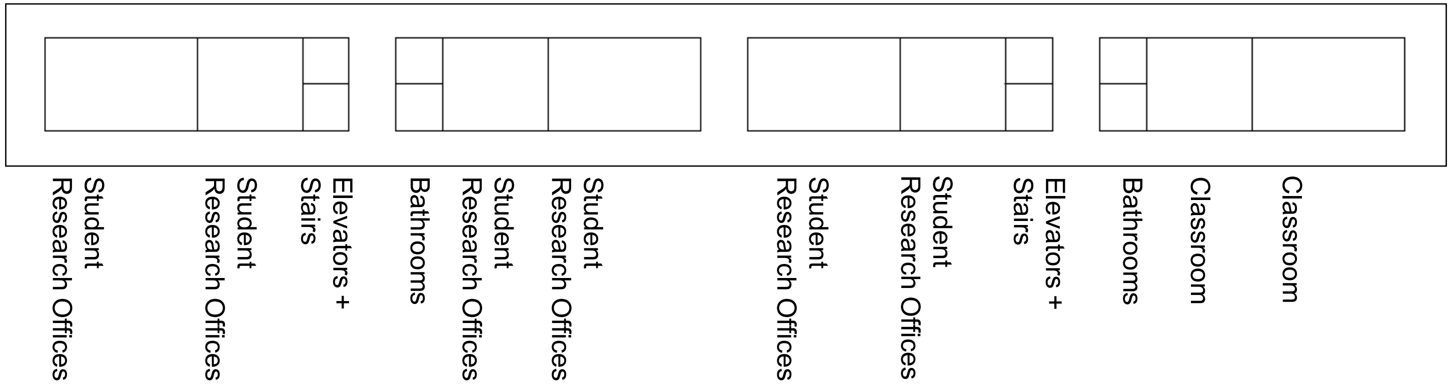


Primary Floorplans
Plans

2nd Floor

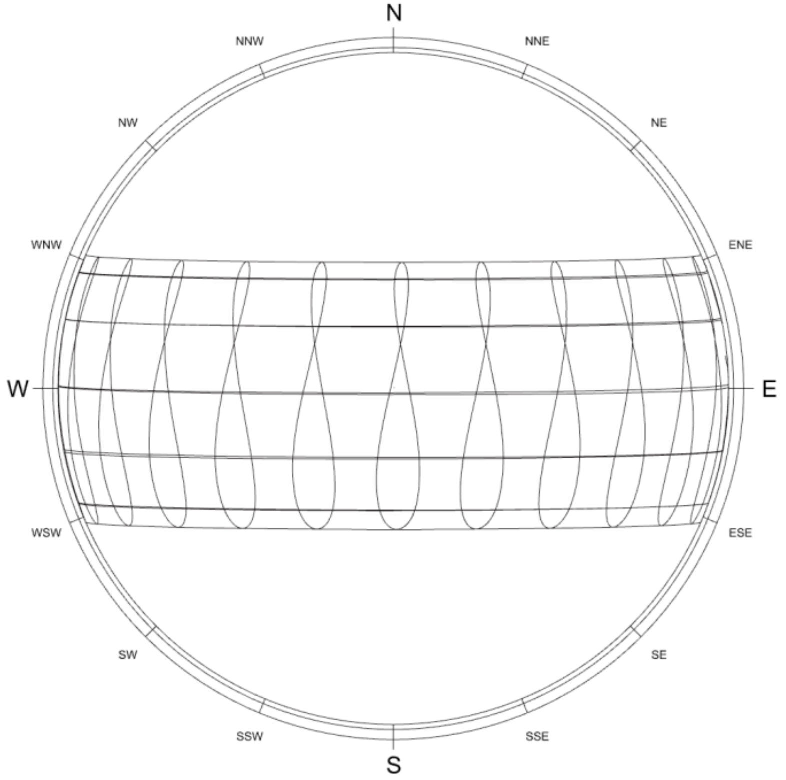


3rd Floor



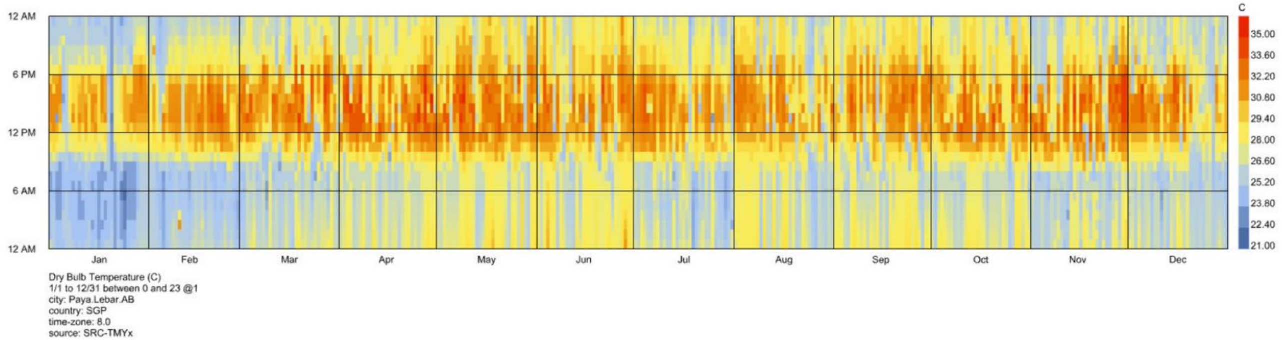
Singapore – Local Climate

Sun Path

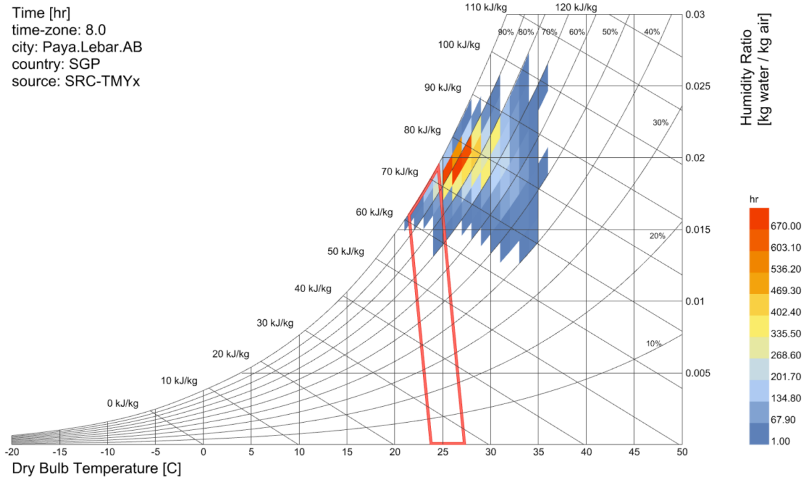


city: Paya.Lebar.AB

Dry Bulb



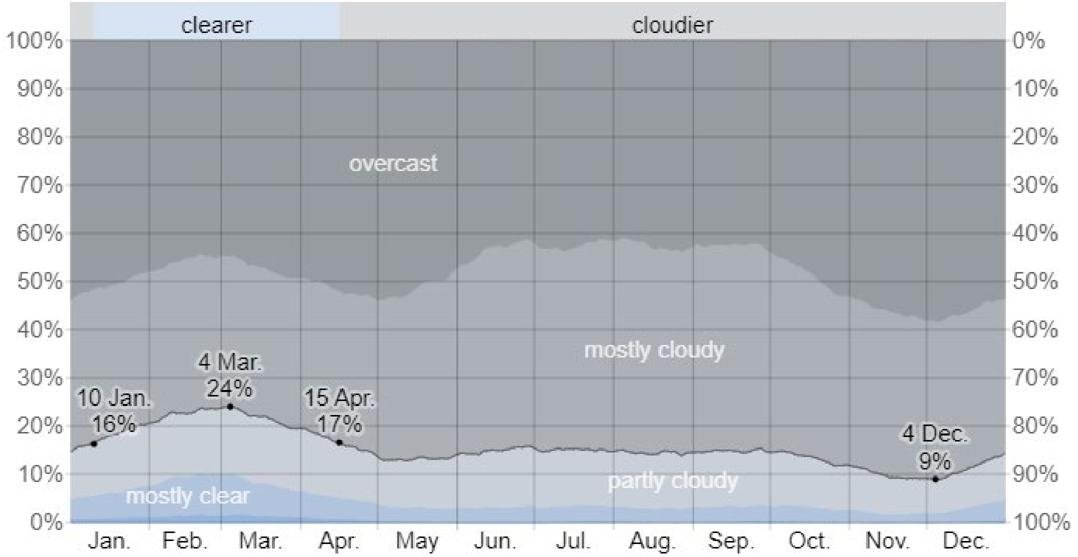
Relative Humidity



Singapore – Local Climate

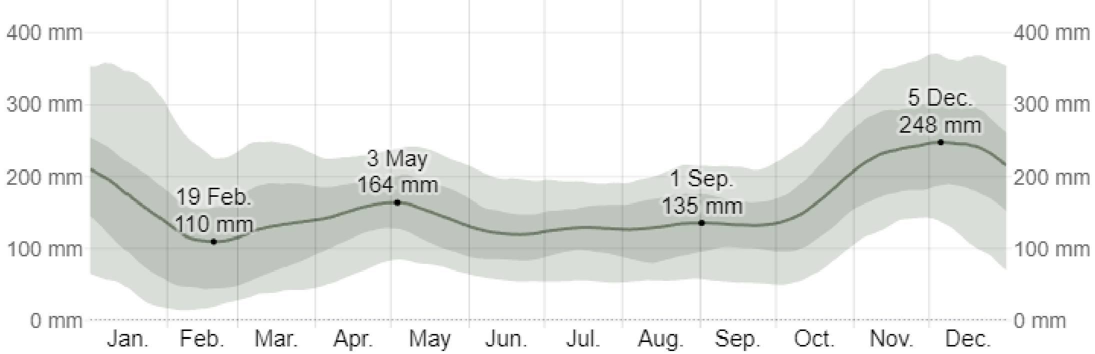
According to the data presented in the graphs to the left. The wet season in Singapore lasts from end of October – start of February. Furthermore, cloud cover is consistently present over Singapore throughout the whole year. With is most clear weather at the end of the wet season.

Yearly Average Cloud Cover



Weatherspark.com(2023)

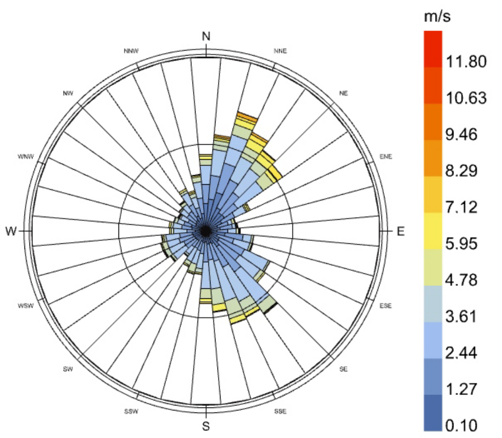
Yearly Average Precipitation



Weatherspark.com(2023)

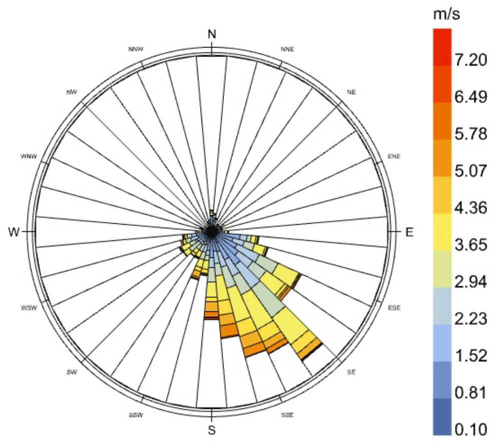
Singapore - Winds

The winds roses to the right represent the wind direction and speeds throughout the entire year, wet season, and dry season. From this it's very clear that the building needs to be positions in such a way that it captures the south easterly winds during Singapore's dry season and the north easterly winds during the wet season.



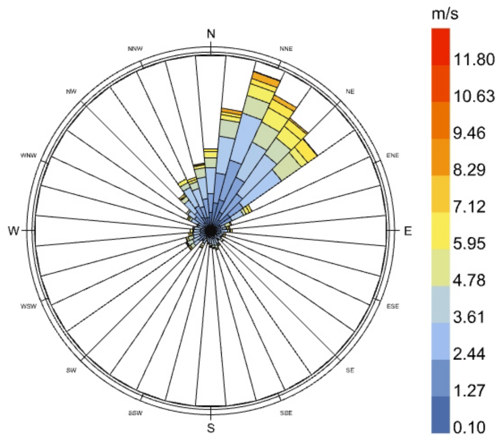
Wind Speed (m/s)
city: Paya.Lebar.AB
country: SGP
time-zone: 8.0
source: SRC-TMYx
period: 1/1 to 12/31 between 0 and 23 @1
Calm for 15.99% of the time = 1401 hours.
Each closed polyline shows frequency of 4.1% = 300 hours.

Yearly



Wind Speed (m/s)
city: Paya.Lebar.AB
country: SGP
time-zone: 8.0
source: SRC-TMYx
period: 6/1 to 9/30 between 0 and 23 @1
Calm for 16.97% of the time = 497 hours.
Each closed polyline shows frequency of 12.3% = 300 hours.

Dry Season

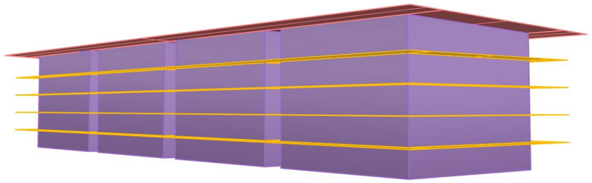


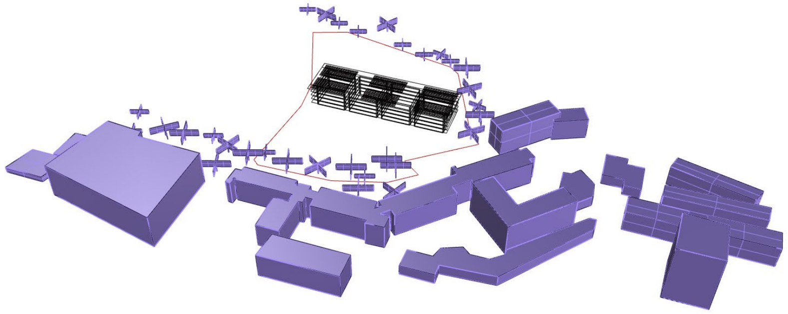
Wind Speed (m/s)
city: Paya.Lebar.AB
country: SGP
time-zone: 8.0
source: SRC-TMYx
period: 12/1 to 3/31 between 0 and 23 @1
Calm for 9.75% of the time = 283 hours.
Each closed polyline shows frequency of 11.4% = 300 hours.

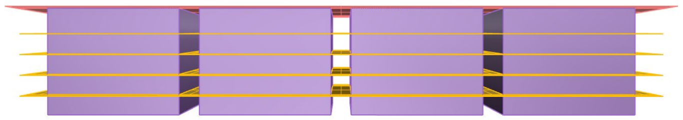
Wet Season

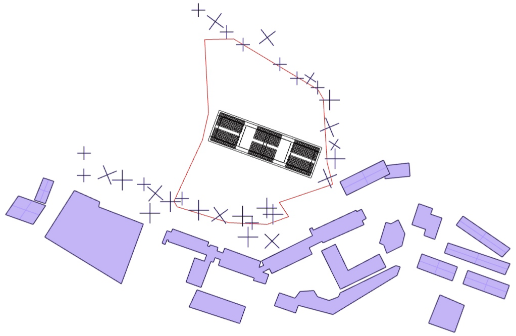
Baseline Simulation Results

Baseline Model Images



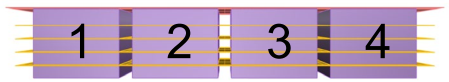




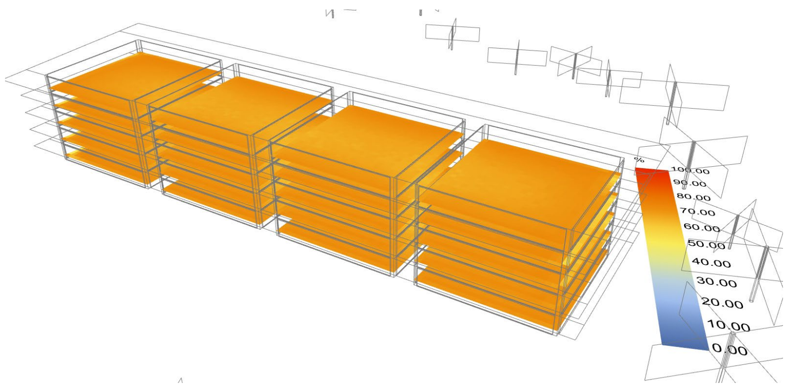


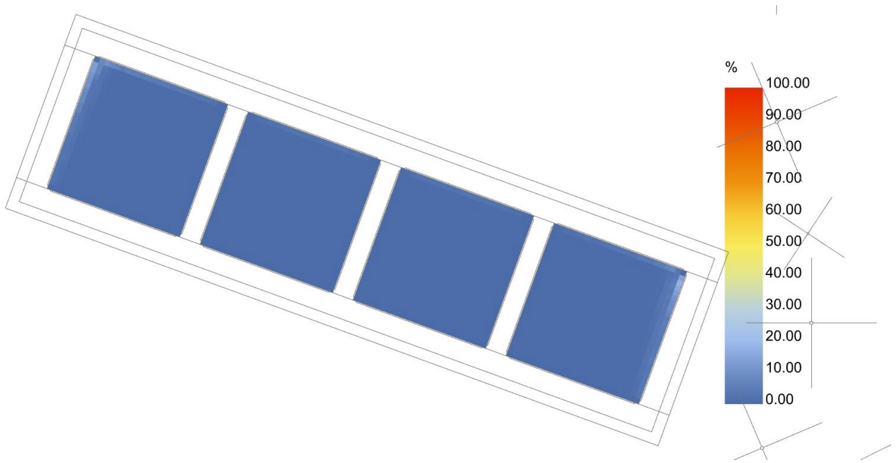
Baseline Simulation Results
sDA

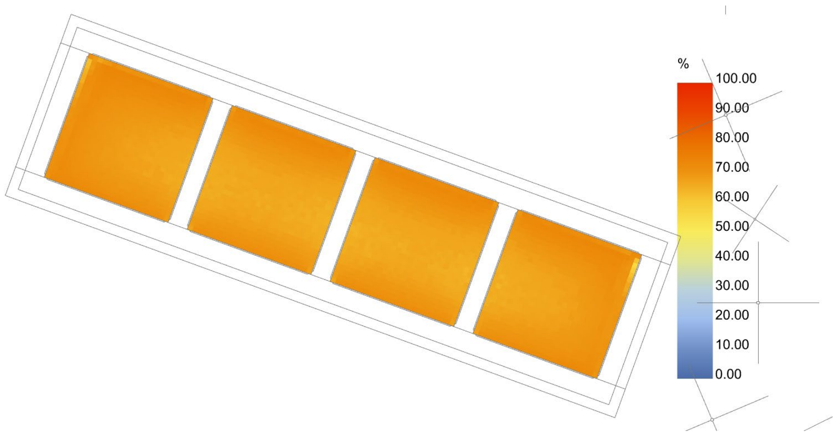
		sDA in Each Room {0;0;0}		{0;0;0;0}
Tower 1	0	0.636923	0	SensorGrid: Flr1_Ground_massModel_1_Floor1_Room1 [650 sensors]
	1	0.618462	1	SensorGrid: Flr1_massModel_1_Floor1_Room1 [650 sensors]
	2	0.72	2	SensorGrid: Flr2_massModel_1_Floor1_Room1 [650 sensors]
	3	0.764615	3	SensorGrid: Flr3_massModel_1_Floor1_Room1 [650 sensors]
	4	0.893846	4	SensorGrid: Flr1_Top_massModel_1_Floor1_Room1 [650 sensors]
Tower 2	5	0.58432	5	SensorGrid: Flr1_Ground_massModel_2_Floor1_Room1 [676 sensors]
	6	0.468935	6	SensorGrid: Flr1_massModel_2_Floor1_Room1 [676 sensors]
	7	0.502959	7	SensorGrid: Flr2_massModel_2_Floor1_Room1 [676 sensors]
	8	0.519231	8	SensorGrid: Flr3_massModel_2_Floor1_Room1 [676 sensors]
	9	0.621302	9	SensorGrid: Flr1_Top_massModel_2_Floor1_Room1 [676 sensors]
Tower 3	10	0.606509	10	SensorGrid: Flr1_Ground_massModel_3_Floor1_Room1 [676 sensors]
	11	0.486686	11	SensorGrid: Flr1_massModel_3_Floor1_Room1 [676 sensors]
	12	0.513314	12	SensorGrid: Flr2_massModel_3_Floor1_Room1 [676 sensors]
	13	0.529586	13	SensorGrid: Flr3_massModel_3_Floor1_Room1 [676 sensors]
	14	0.640533	14	SensorGrid: Flr1_Top_massModel_3_Floor1_Room1 [676 sensors]
Tower 4	15	0.905325	15	SensorGrid: Flr1_Ground_massModel_4_Floor1_Room1 [676 sensors]
	16	0.810651	16	SensorGrid: Flr1_massModel_4_Floor1_Room1 [676 sensors]
	17	0.841716	17	SensorGrid: Flr2_massModel_4_Floor1_Room1 [676 sensors]
	18	0.860947	18	SensorGrid: Flr3_massModel_4_Floor1_Room1 [676 sensors]
	19	0.945266	19	SensorGrid: Flr1_Top_massModel_4_Floor1_Room1 [676 sensors]

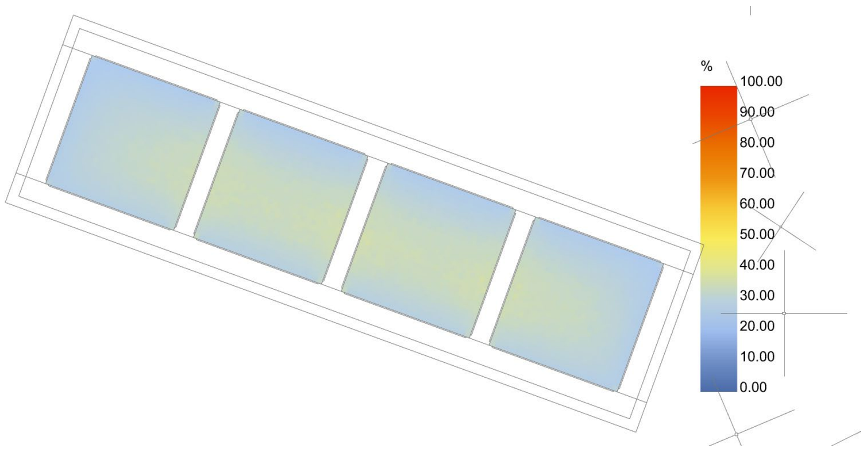


Baseline Simulation Results
UDI









Baseline Simulation Results
Thermal Comfort

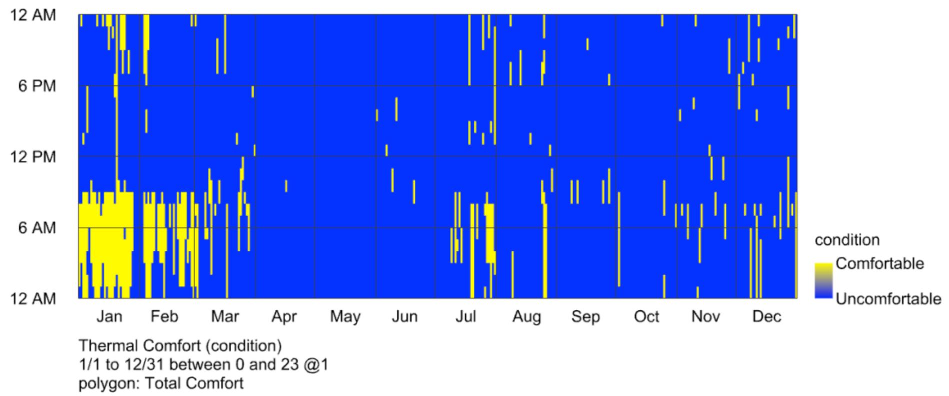
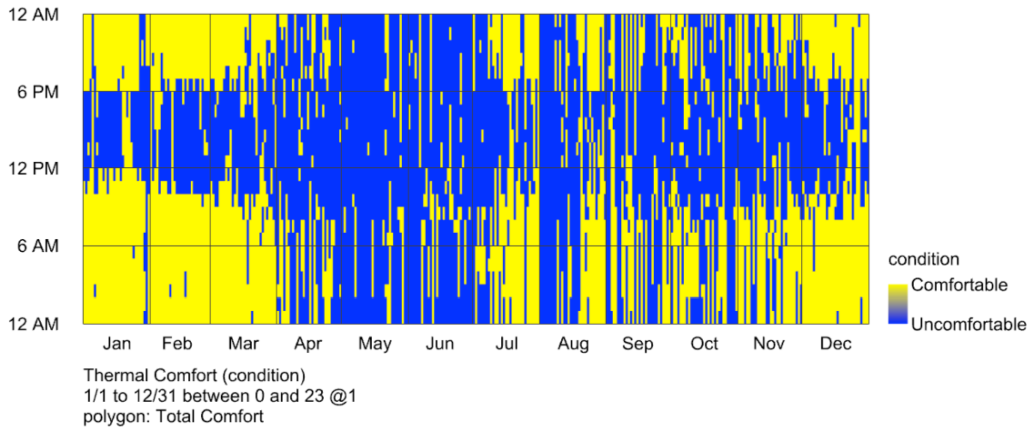
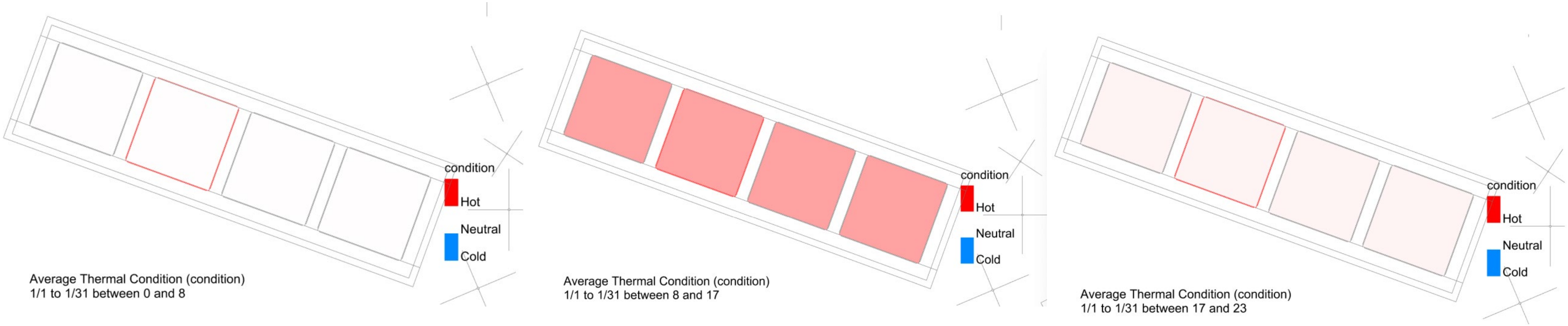


Figure 18: Annual thermal chart with no fans

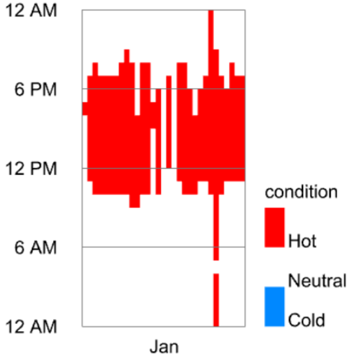


Baseline Simulation Results
Thermal Comfort - January

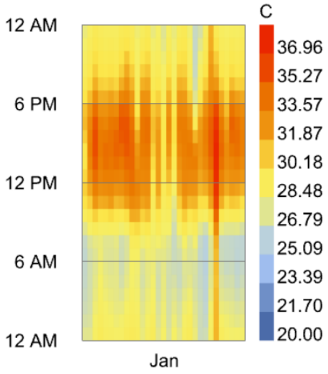


Baseline Simulation Results

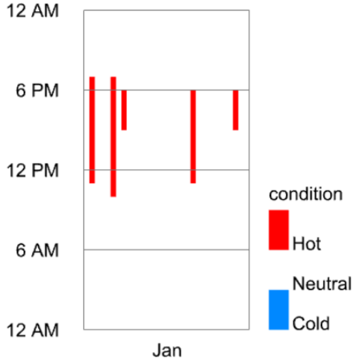
Thermal Condition - January



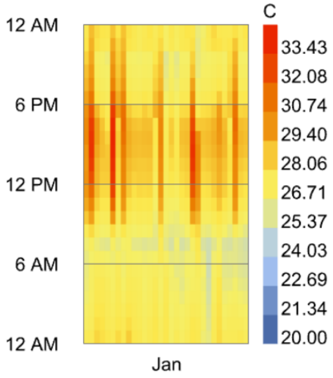
Thermal Condition (condition)
1/1 to 1/31 between 0 and 23 @1
Zone: FLR1_MASSMODEL_3_FLOOR1_ROOM1



Temperature (C)
1/1 to 1/31 between 0 and 23 @1
type: Zone Operative Temperature
Zone: FLR1_MASSMODEL_3_FLOOR1_ROOM1

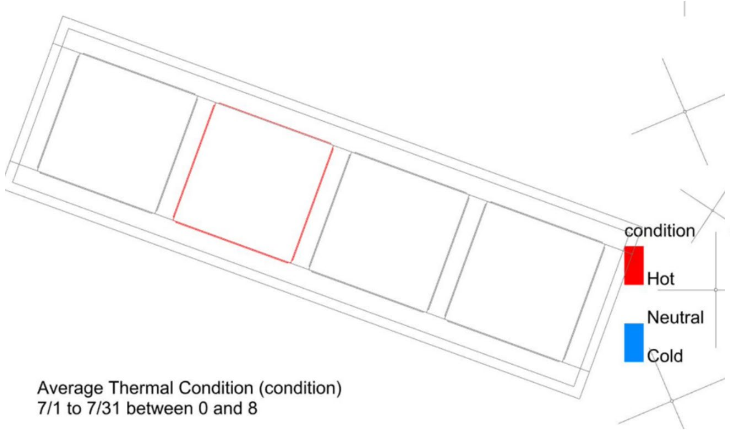


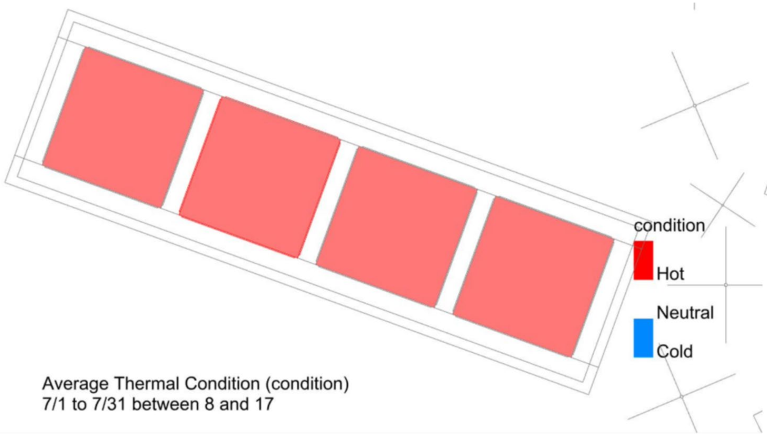
Thermal Condition (condition)
1/1 to 1/31 between 0 and 23 @1
Zone: FLR1_MASSMODEL_3_FLOOR1_ROOM1

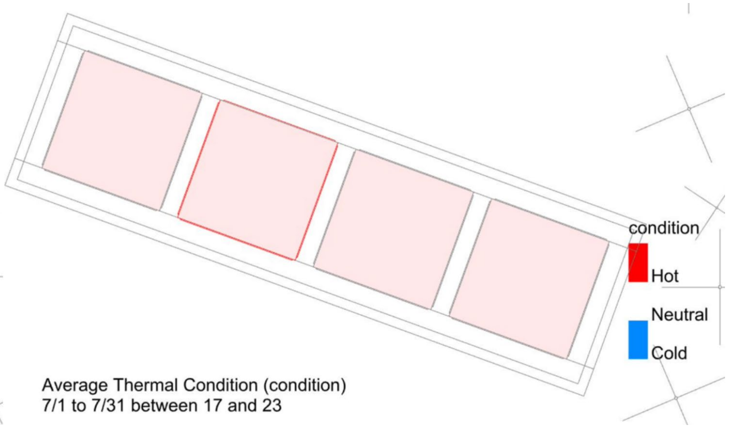


Temperature (C)
1/1 to 1/31 between 0 and 23 @1
type: Zone Operative Temperature
Zone: FLR1_MASSMODEL_3_FLOOR1_ROOM1

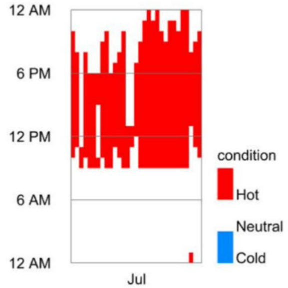
Baseline Simulation Results
Thermal Condition - July



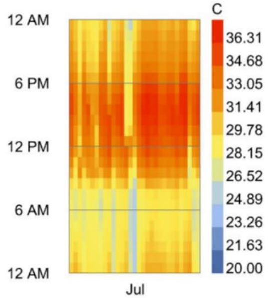




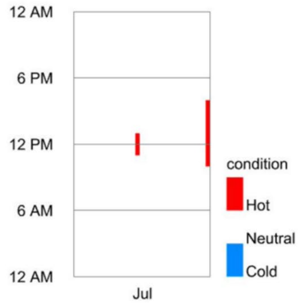
Baseline Simulation Results
Thermal Condition - July



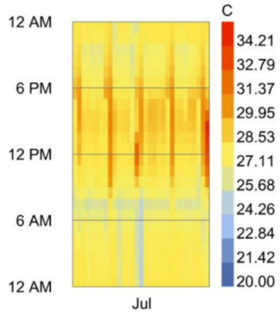
Thermal Condition (condition)
7/1 to 7/31 between 0 and 23 @1
Zone: FLR1_MASSMODEL_3_FLOOR1_ROOM1



Temperature (C)
7/1 to 7/31 between 0 and 23 @1
Zone: FLR1_MASSMODEL_3_FLOOR1_ROOM1
type: Zone Operative Temperature



Thermal Condition (condition)
7/1 to 7/31 between 0 and 23 @1
Zone: FLR1_MASSMODEL_3_FLOOR1_ROOM1



Temperature (C)
7/1 to 7/31 between 0 and 23 @1
Zone: FLR1_MASSMODEL_3_FLOOR1_ROOM1
type: Zone Operative Temperature

Baseline Simulation Results
Thermal Comfort

Month	Hot %	Comfortable %	Cold %
January	39%	61%	0%
July	32%	68%	0%

Month	Hot %	Comfortable %	Cold %
January	4%	96%	0%
July	5%	95%	0%

Baseline Simulation Results

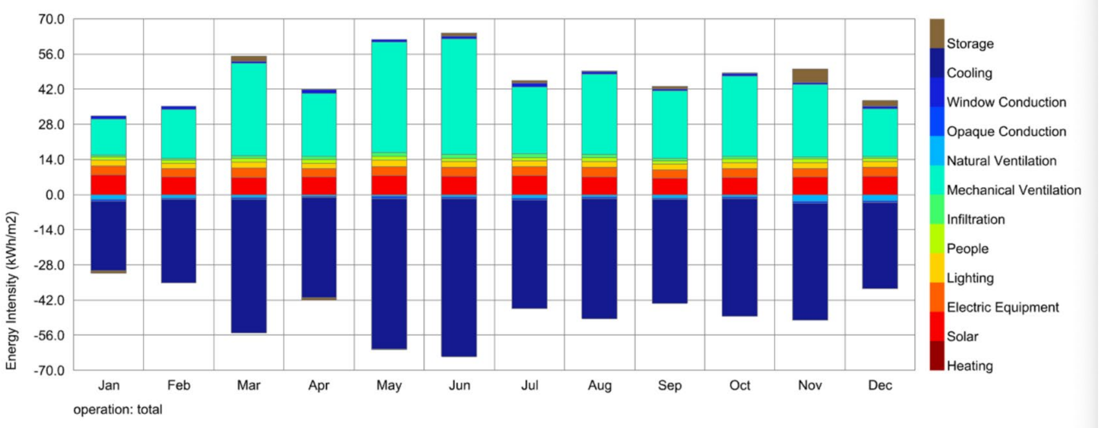
Thermal Daytime Comfort

Month	Comfort Daytime Period (0600-1800)
January	22%
July	33%

Month	Comfort Daytime Period (0600-1800)
January	91%
July	97%

Baseline Simulation Results

Energy Usage (EUI Heating / Cooling)



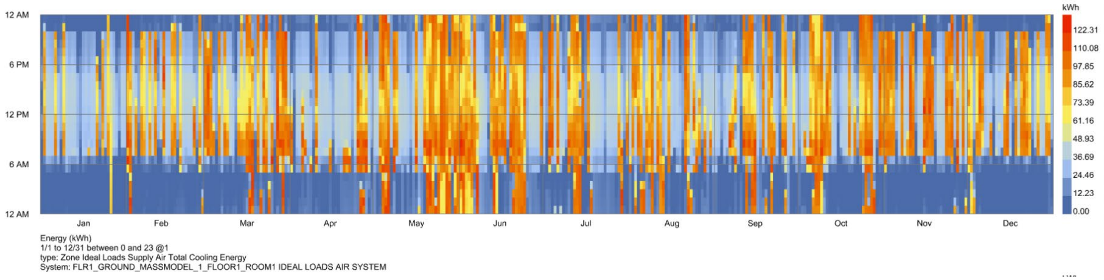
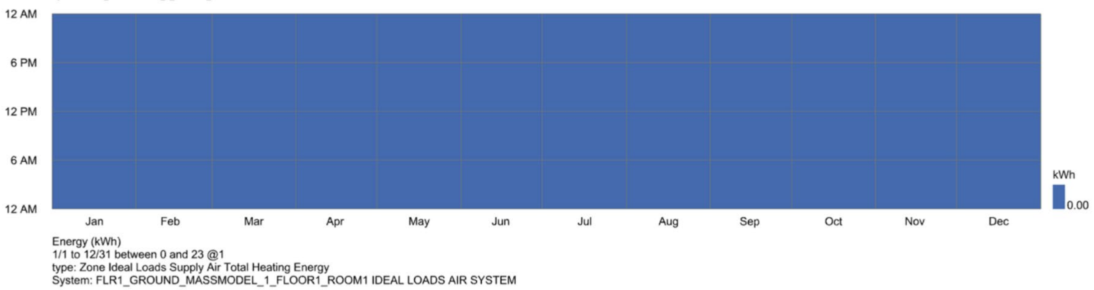
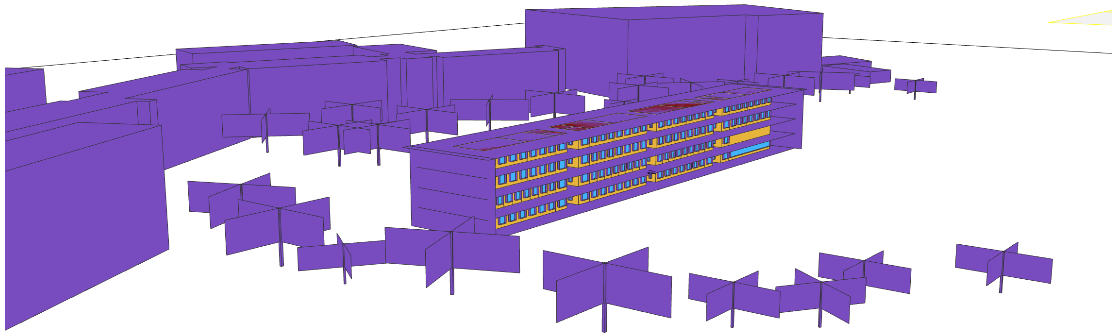


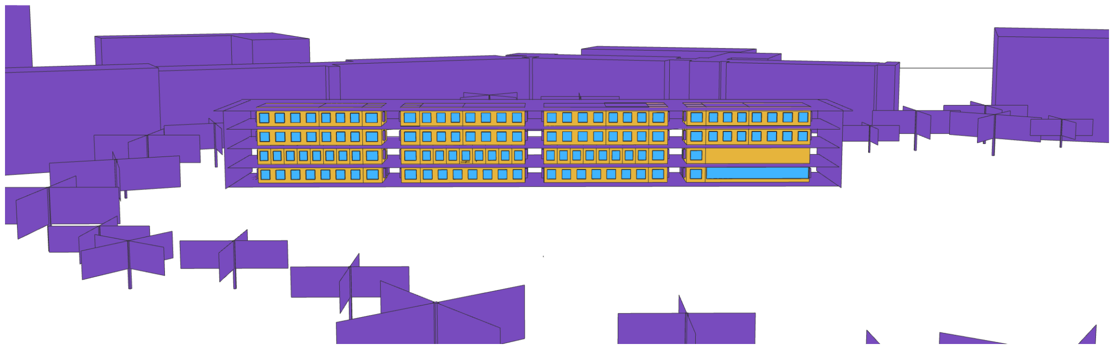
Figure 31 : Cooling energy annual usage

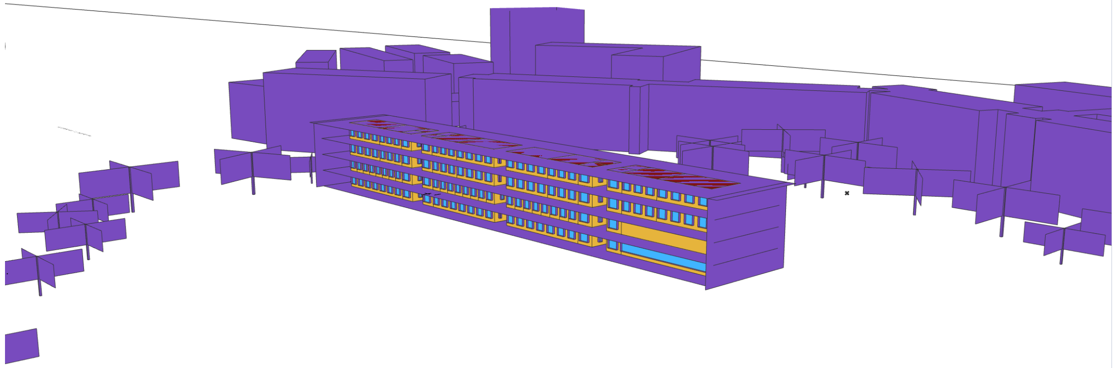


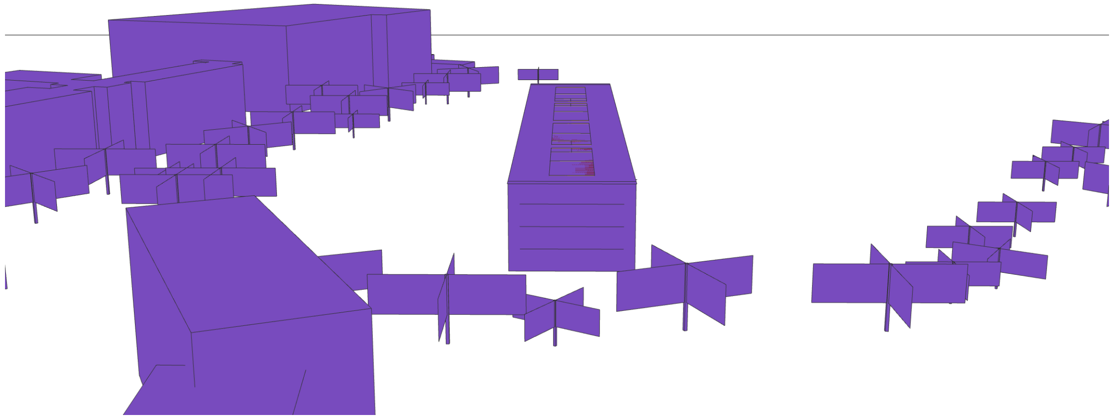
Final Model Simulation Results

Model Images









Final Model Simulation Results
sDA

	sDA
Mean	0.642566
Median	0.5
Mode	0.5625
Standard Deviation	0.205575

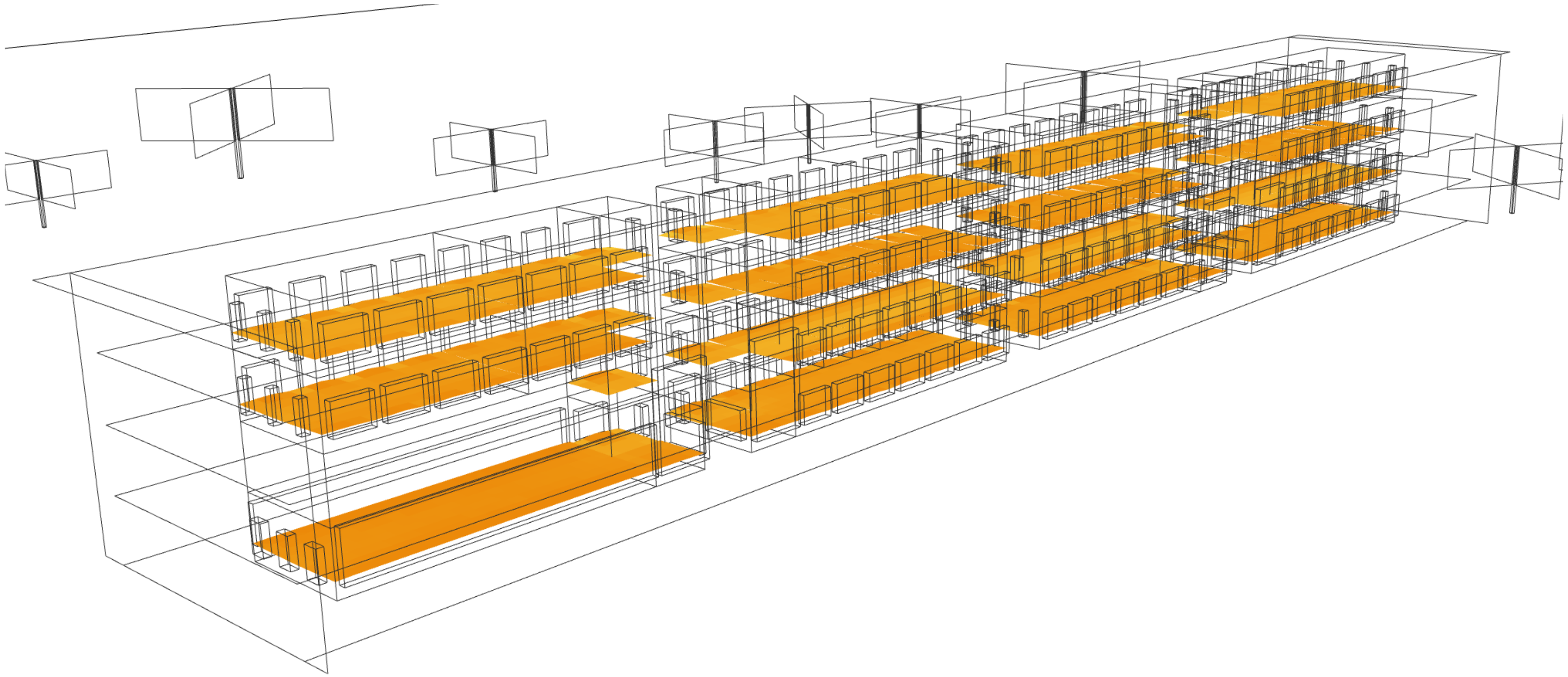
sDA in Each Room	{0;0;0}
0	0.1875
1	0.25
2	0.625
3	0.625
4	0.5625
5	0.5625
6	0.4375
7	0.4375
8	0.25
9	0.1875
10	0.625
11	0.6875
12	0.5
13	0.6875
14	0.5
15	0.5625
16	0.986486
17	1
18	1
19	1
20	0.842105
21	0.824176
22	1
23	1
24	1
25	0.989011
26	0.5
27	0.5
28	0.666667
29	0.5
30	0.666667
31	0.5
32	0.5
33	0.5
34	0.666667
35	0.5
36	0.666667
37	0.5
38	0.666667
39	0.5
40	0.666667
41	0.666667
42	0.5
43	0.5
44	0.5
45	0.5

	{0;0;0;0}
0	SensorGrid: restroom_1 [16 sensors]
1	SensorGrid: restroom_2 [16 sensors]
2	SensorGrid: restroom_3 [16 sensors]
3	SensorGrid: restroom_4 [16 sensors]
4	SensorGrid: restroom_5 [16 sensors]
5	SensorGrid: restroom_6 [16 sensors]
6	SensorGrid: restroom_7 [16 sensors]
7	SensorGrid: restroom_8 [16 sensors]
8	SensorGrid: restroom_9 [16 sensors]
9	SensorGrid: restroom_10 [16 sensors]
10	SensorGrid: restroom_11 [16 sensors]
11	SensorGrid: restroom_12 [16 sensors]
12	SensorGrid: restroom_13 [16 sensors]
13	SensorGrid: restroom_14 [16 sensors]
14	SensorGrid: restroom_15 [16 sensors]
15	SensorGrid: restroom_16 [16 sensors]
16	SensorGrid: conference_1 [74 sensors]
17	SensorGrid: conference_2 [50 sensors]
18	SensorGrid: conference_3 [50 sensors]
19	SensorGrid: conference_4 [74 sensors]
20	SensorGrid: conference_5 [76 sensors]
21	SensorGrid: conference_6 [91 sensors]
22	SensorGrid: conference_7 [74 sensors]
23	SensorGrid: conference_8 [52 sensors]
24	SensorGrid: conference_9 [76 sensors]
25	SensorGrid: conference_10 [91 sensors]
26	SensorGrid: closedOffice_1 [8 sensors]
27	SensorGrid: closedOffice_2 [8 sensors]
28	SensorGrid: closedOffice_3 [6 sensors]
29	SensorGrid: closedOffice_4 [8 sensors]
30	SensorGrid: closedOffice_5 [6 sensors]
31	SensorGrid: closedOffice_6 [8 sensors]
32	SensorGrid: closedOffice_7 [6 sensors]
33	SensorGrid: closedOffice_8 [8 sensors]
34	SensorGrid: closedOffice_9 [6 sensors]
35	SensorGrid: closedOffice_10 [8 sensors]
36	SensorGrid: closedOffice_11 [6 sensors]
37	SensorGrid: closedOffice_12 [8 sensors]
38	SensorGrid: closedOffice_13 [6 sensors]
39	SensorGrid: closedOffice_14 [8 sensors]
40	SensorGrid: closedOffice_15 [6 sensors]
41	SensorGrid: closedOffice_16 [6 sensors]
42	SensorGrid: closedOffice_17 [8 sensors]
43	SensorGrid: closedOffice_18 [8 sensors]
44	SensorGrid: closedOffice_19 [6 sensors]
45	SensorGrid: closedOffice_20 [8 sensors]
46	SensorGrid: closedOffice_21 [6 sensors]

46	0.333333
47	0.5
48	0.5
49	0.5
50	0.5
51	0.5
52	0.5
53	0.5
54	0.5
55	0.5
56	0.333333
57	0.5
58	0.666667
59	0.5
60	0.5
61	0.5
62	0.5
63	0.666667
64	0.5
65	0.666667
66	0.5
67	0.666667
68	0.5
69	0.666667
70	0.5
71	0.5
72	0.5
73	0.666667
74	0.725275
75	0.658228
76	0.7875
77	0.846154
78	0.97449
79	0.945545
80	0.904762
81	0.701149
82	0.974874
83	1
84	1
85	1
86	1
87	1

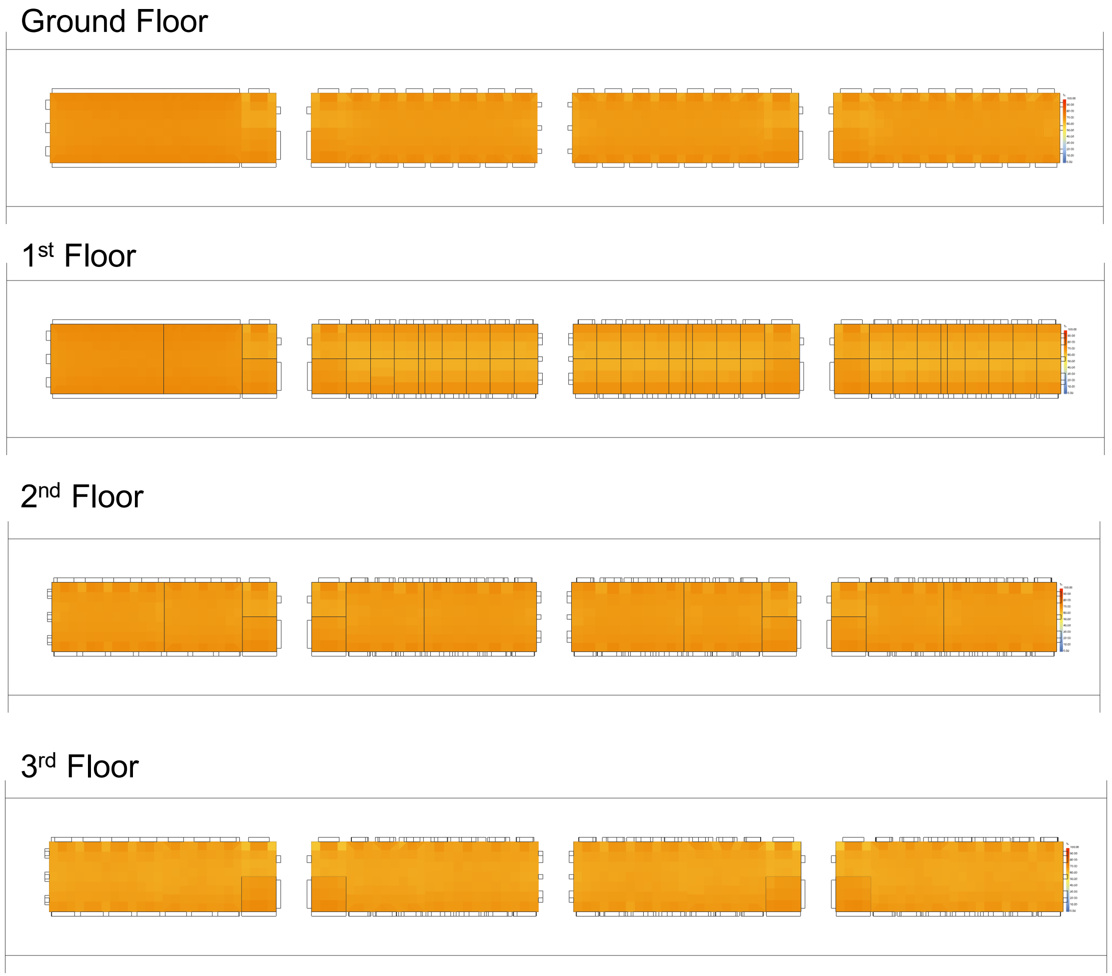
47	SensorGrid: closedOffice_22 [8 sensors]
48	SensorGrid: closedOffice_23 [6 sensors]
49	SensorGrid: closedOffice_24 [8 sensors]
50	SensorGrid: closedOffice_25 [6 sensors]
51	SensorGrid: closedOffice_26 [8 sensors]
52	SensorGrid: closedOffice_27 [6 sensors]
53	SensorGrid: closedOffice_28 [8 sensors]
54	SensorGrid: closedOffice_29 [6 sensors]
55	SensorGrid: closedOffice_30 [8 sensors]
56	SensorGrid: closedOffice_31 [6 sensors]
57	SensorGrid: closedOffice_32 [8 sensors]
58	SensorGrid: closedOffice_33 [6 sensors]
59	SensorGrid: closedOffice_34 [6 sensors]
60	SensorGrid: closedOffice_35 [8 sensors]
61	SensorGrid: closedOffice_36 [6 sensors]
62	SensorGrid: closedOffice_37 [8 sensors]
63	SensorGrid: closedOffice_38 [6 sensors]
64	SensorGrid: closedOffice_39 [8 sensors]
65	SensorGrid: closedOffice_40 [6 sensors]
66	SensorGrid: closedOffice_41 [8 sensors]
67	SensorGrid: closedOffice_42 [6 sensors]
68	SensorGrid: closedOffice_43 [8 sensors]
69	SensorGrid: closedOffice_44 [6 sensors]
70	SensorGrid: closedOffice_45 [8 sensors]
71	SensorGrid: closedOffice_46 [8 sensors]
72	SensorGrid: closedOffice_47 [8 sensors]
73	SensorGrid: closedOffice_48 [6 sensors]
74	SensorGrid: openoffice_1 [91 sensors]
75	SensorGrid: openoffice_2 [79 sensors]
76	SensorGrid: openoffice_3 [80 sensors]
77	SensorGrid: openoffice_4 [91 sensors]
78	SensorGrid: openoffice_5 [196 sensors]
79	SensorGrid: openoffice_6 [202 sensors]
80	SensorGrid: openoffice_7 [84 sensors]
81	SensorGrid: openoffice_8 [87 sensors]
82	SensorGrid: openoffice_9 [199 sensors]
83	SensorGrid: lecture theatre [189 sensors]
84	SensorGrid: unconditioned_1 [12 sensors]
85	SensorGrid: unconditioned_2 [12 sensors]
86	SensorGrid: unconditioned_3 [12 sensors]
87	SensorGrid: unconditioned_4 [12 sensors]

Final Model Simulation Results
UDI



Final Model Simulation Results
UDI

The UDI simulation results show an even distribution of natural light within the spaces. The spaces that suffer the most are the individual offices and the top floor. This can be easily explained as the top floor has the largest overhang and the individual offices due to their size have smaller windows compared to the larger spaces.

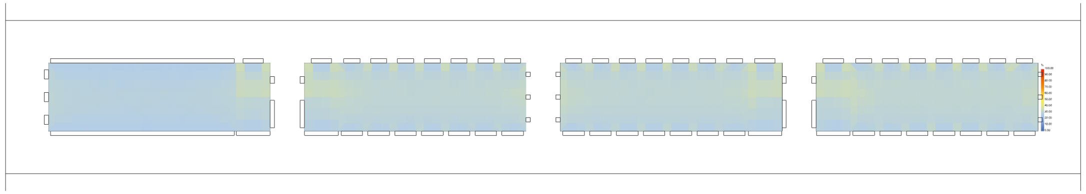


Final Model Simulation Results

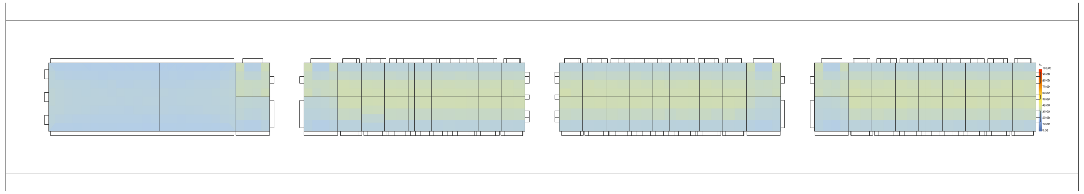
UDI - Low

The UDI Low visualisations make the lower daylight levels in the individual offices and the top floor clearer. However, the levels aren't low enough for it to be an issue.

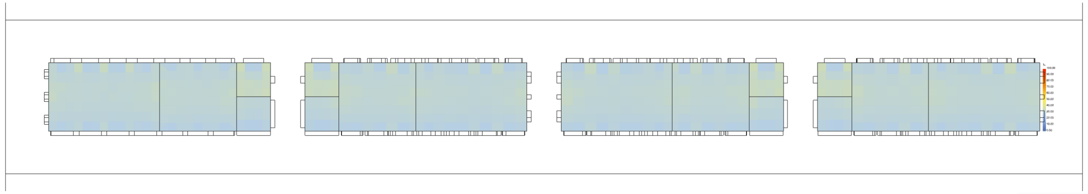
Ground Floor



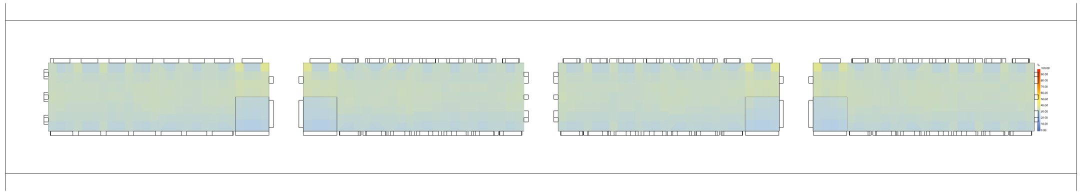
1st Floor



2nd Floor



3rd Floor

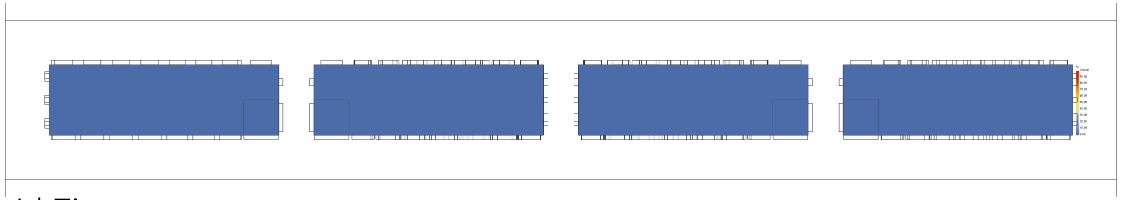


Final Model Simulation Results

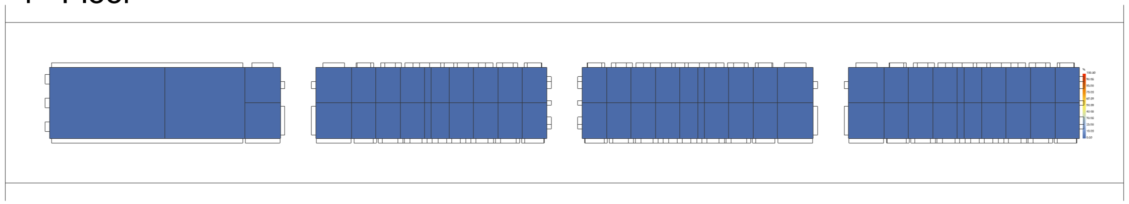
UDI - High

The UDI High visualisations show no issues of unnecessary daylighting within any of the interior spaces on all levels.

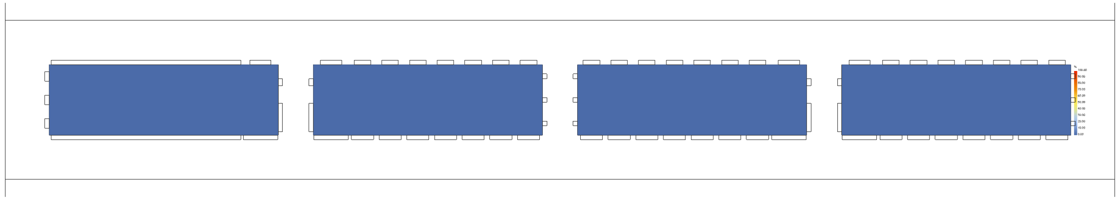
Ground Floor



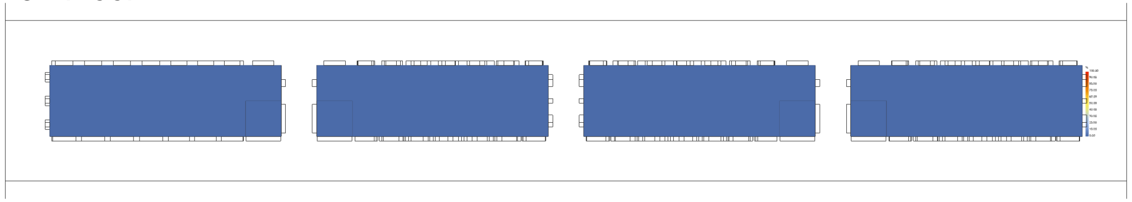
1st Floor



2nd Floor



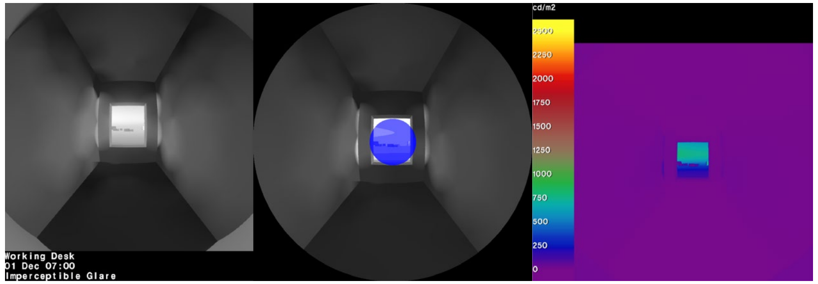
3rd Floor



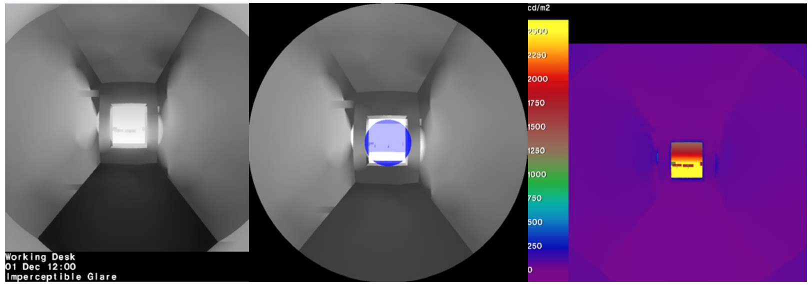
Final Model Simulation Results

Glare Analysis – Individual Office

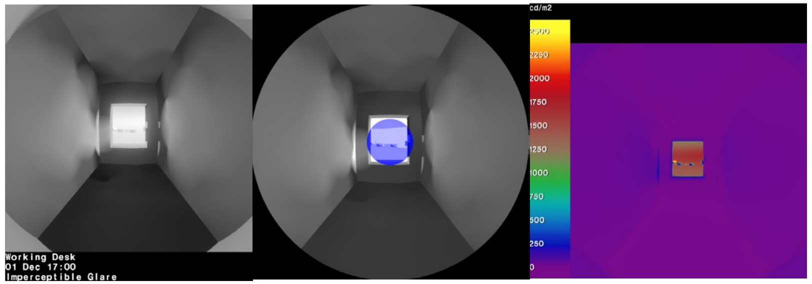
Winter



07:00

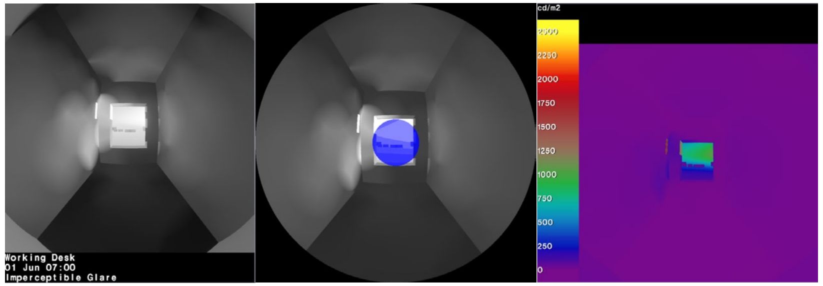


12:00

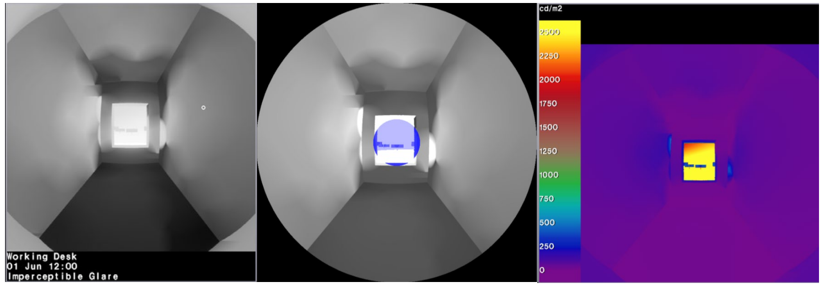


17:00

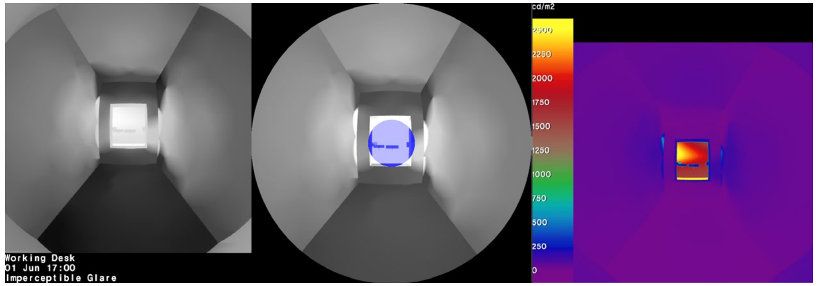
Summer



07:00



12:00



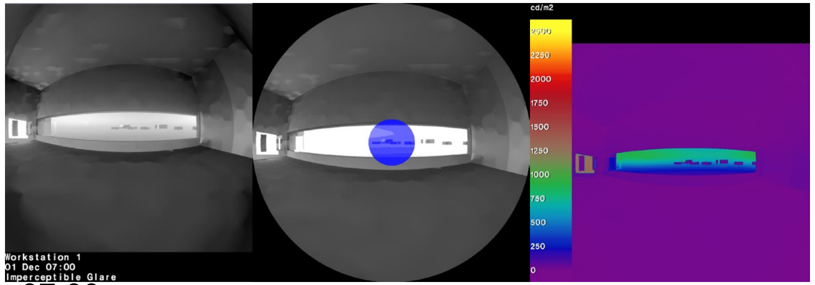
17:00

For the individual offices there is imperceptible glare in the morning, midday & afternoon during not only the winter months but also the summer months

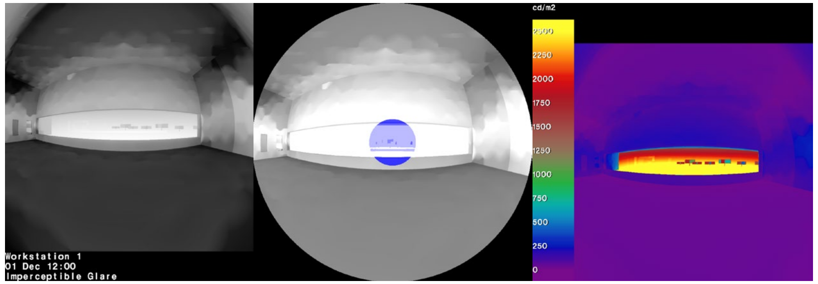
Final Model Simulation Results

Glare Analysis – Lecture

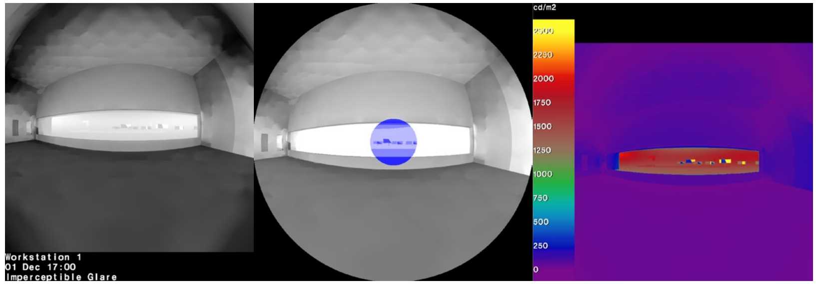
Winter



07:00

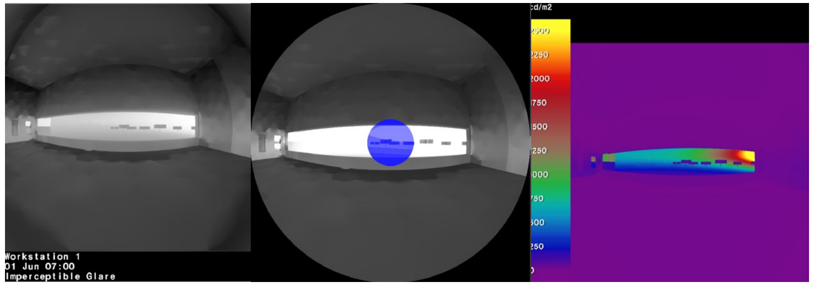


12:00

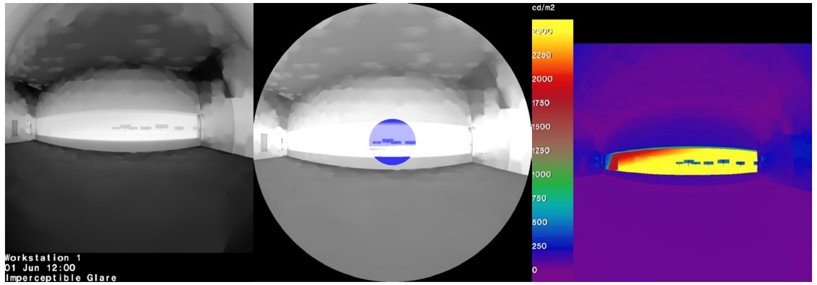


17:00

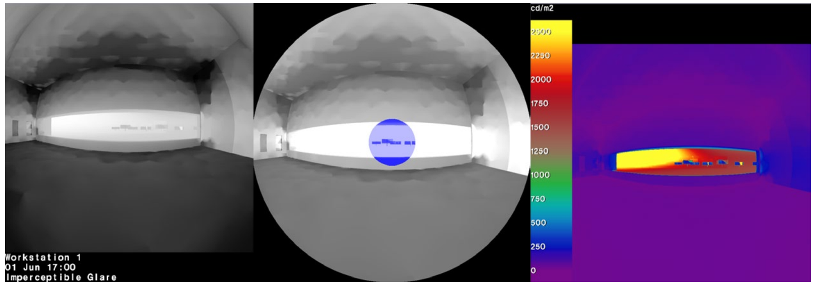
Summer



07:00



12:00



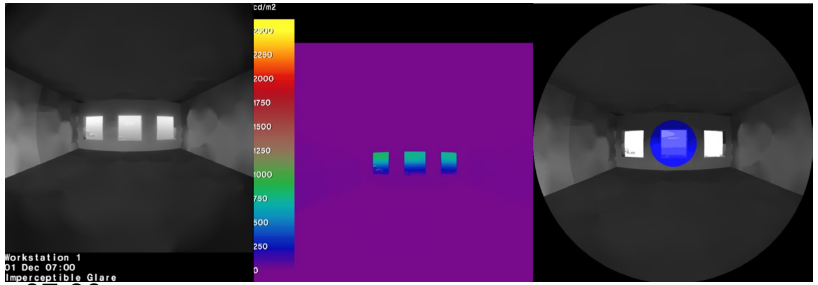
17:00

For the lecture theatre there is imperceptible glare in the morning, midday & afternoon during not only the winter months but also the summer months

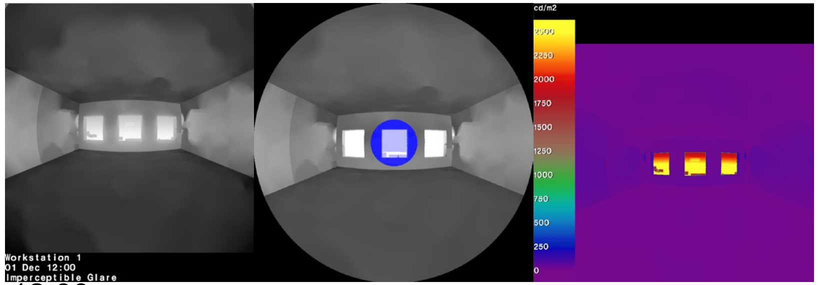
Final Model Simulation Results

Glare Analysis – Workstation

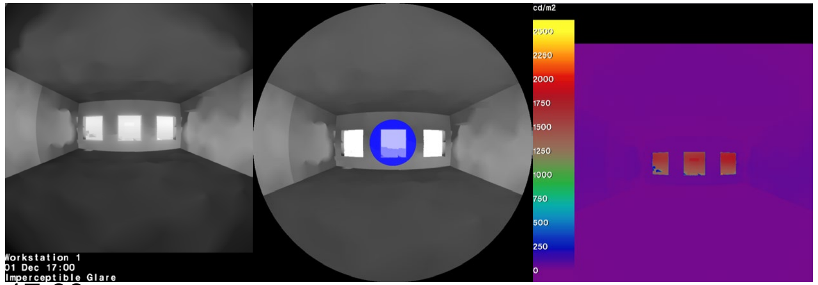
Winter



07:00

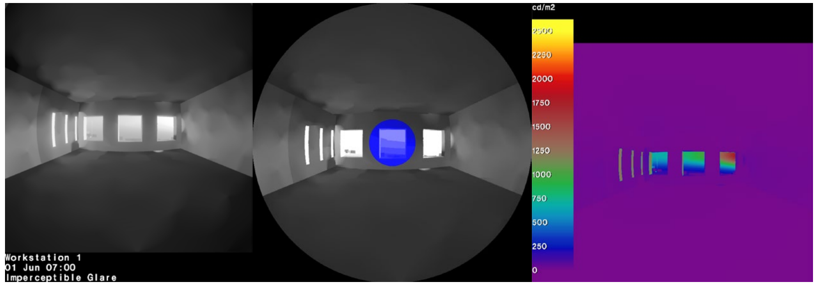


12:00

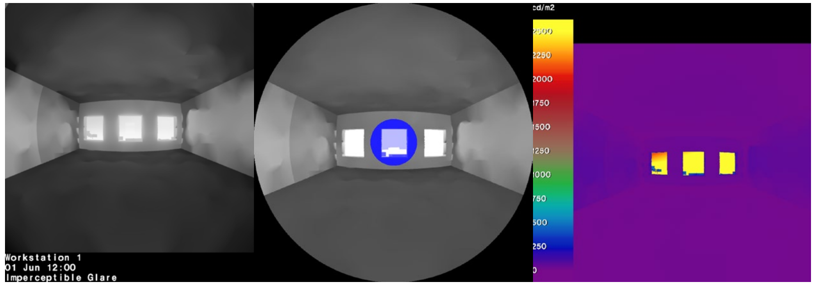


17:00

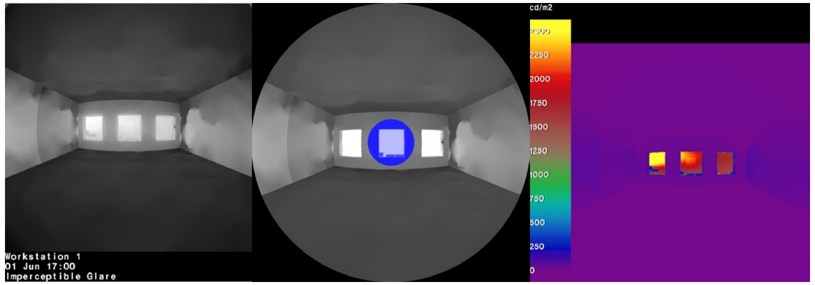
Summer



07:00



12:00

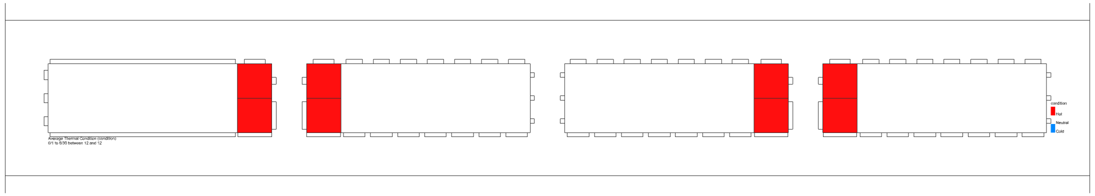


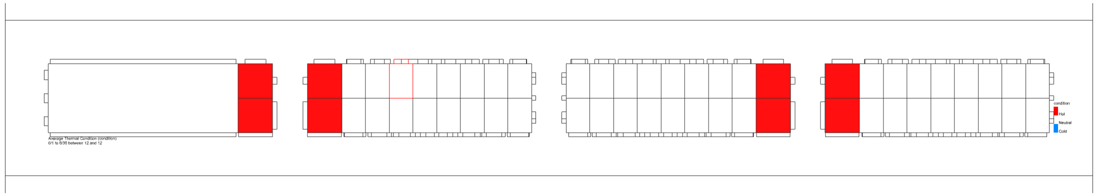
17:00

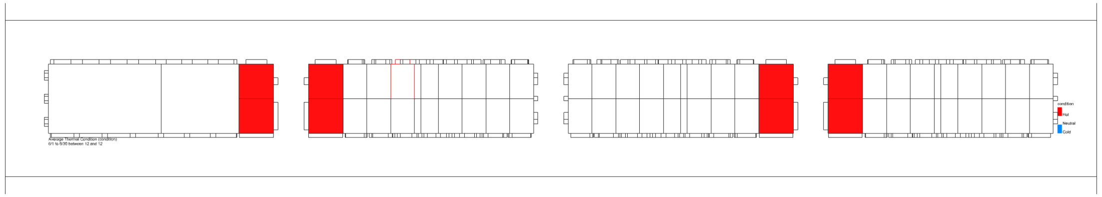
For the workstations theatre there is imperceptible glare in the morning, midday & afternoon during not only the winter months but also the summer months

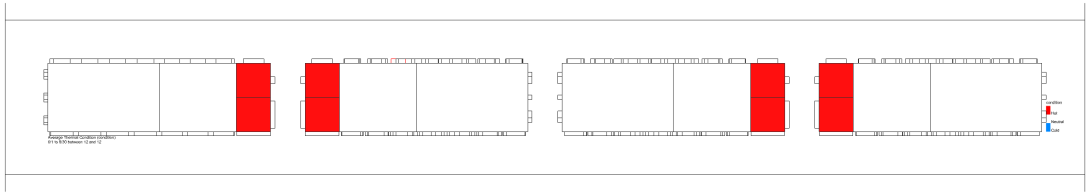
Thermal Comfort

June – Mid-Day





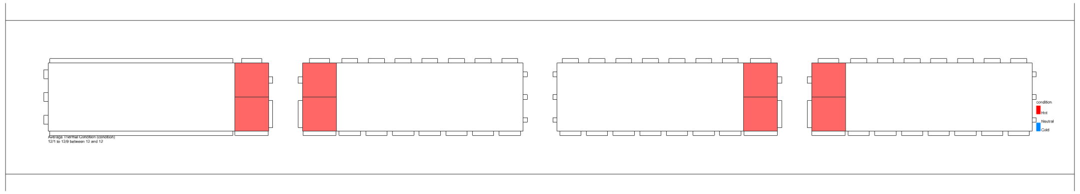


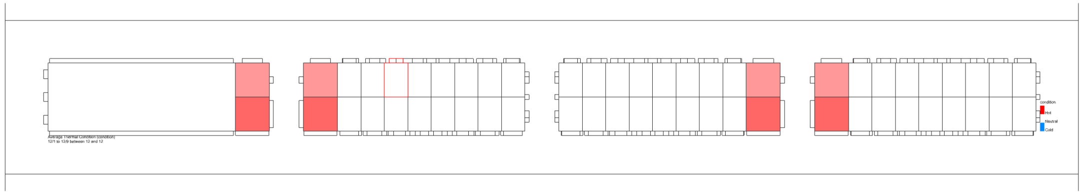


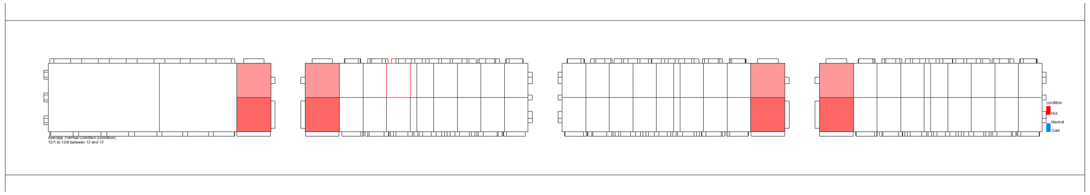
With the AC during peak summer the building is able to stay within the comfort range throughout the entire building. The elevator and staircase are unconditioned.

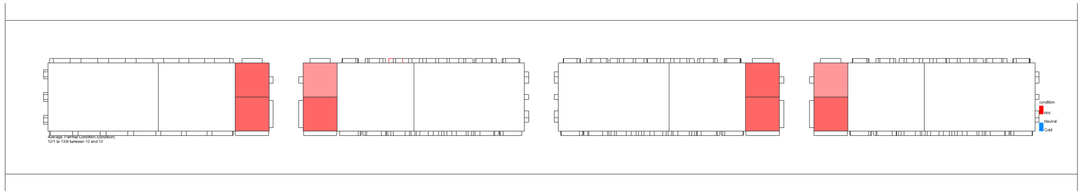
Thermal Comfort

December – Mid-Day





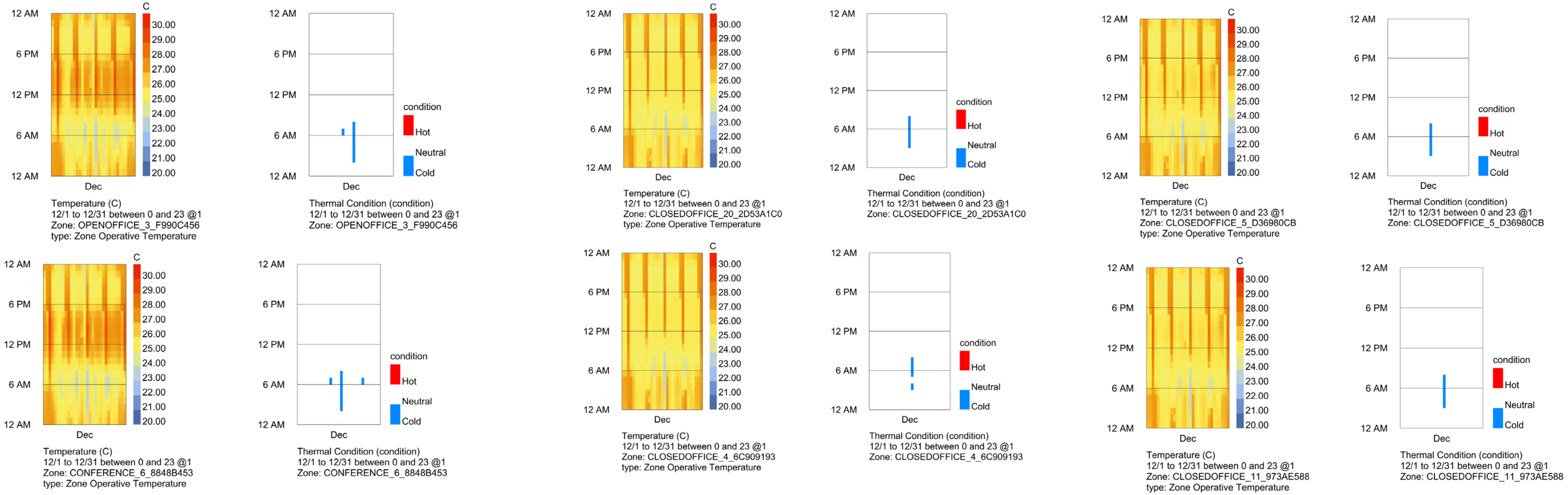




With the AC during peak winter the building is able to stay within the comfort range throughout the entire building. The elevator and staircase are unconditioned.

Zone Operative Temperature

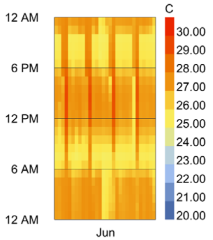
December



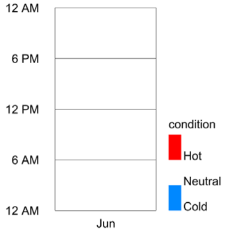
With the AC during peak winter the building is able to stay within the comfort range throughout the entire building. With only a couple of the rooms hitting the 27 degree temperatures.

Zone Operative Temperature

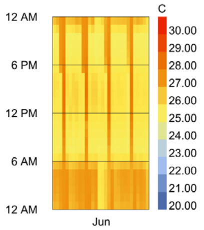
June



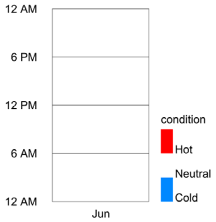
Temperature (C)
6/1 to 6/30 between 0 and 23 @1
Zone: OPENOFFICE_3_F990C456
type: Zone Operative Temperature



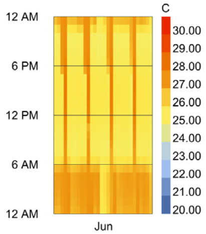
Thermal Condition (condition)
6/1 to 6/30 between 0 and 23 @1
Zone: OPENOFFICE_3_F990C456



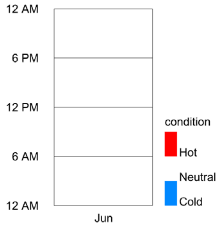
Temperature (C)
6/1 to 6/30 between 0 and 23 @1
Zone: CLOSEDOFFICE_20_2D53A1C0
type: Zone Operative Temperature



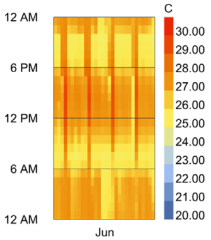
Thermal Condition (condition)
6/1 to 6/30 between 0 and 23 @1
Zone: CLOSEDOFFICE_20_2D53A1C0



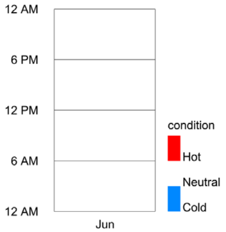
Temperature (C)
6/1 to 6/30 between 0 and 23 @1
Zone: CLOSEDOFFICE_5_D36980CB
type: Zone Operative Temperature



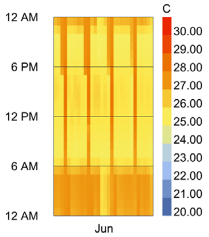
Thermal Condition (condition)
6/1 to 6/30 between 0 and 23 @1
Zone: CLOSEDOFFICE_5_D36980CB



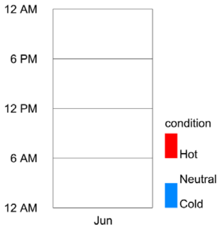
Temperature (C)
6/1 to 6/30 between 0 and 23 @1
Zone: CONFERENCE_6_8848B453
type: Zone Operative Temperature



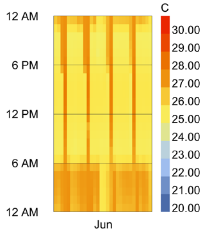
Thermal Condition (condition)
6/1 to 6/30 between 0 and 23 @1
Zone: CONFERENCE_6_8848B453



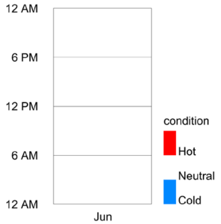
Temperature (C)
6/1 to 6/30 between 0 and 23 @1
Zone: CLOSEDOFFICE_4_6C909193
type: Zone Operative Temperature



Thermal Condition (condition)
6/1 to 6/30 between 0 and 23 @1
Zone: CLOSEDOFFICE_4_6C909193



Temperature (C)
6/1 to 6/30 between 0 and 23 @1
Zone: CLOSEDOFFICE_11_973AE588
type: Zone Operative Temperature



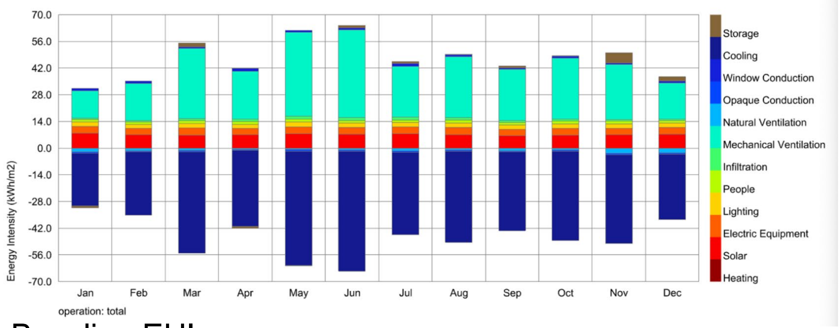
Thermal Condition (condition)
6/1 to 6/30 between 0 and 23 @1
Zone: CLOSEDOFFICE_11_973AE588

With the AC during peak winter the building is able to stay within the comfort range throughout the entire building. With only a couple of the rooms hitting the 27 degree temperatures.

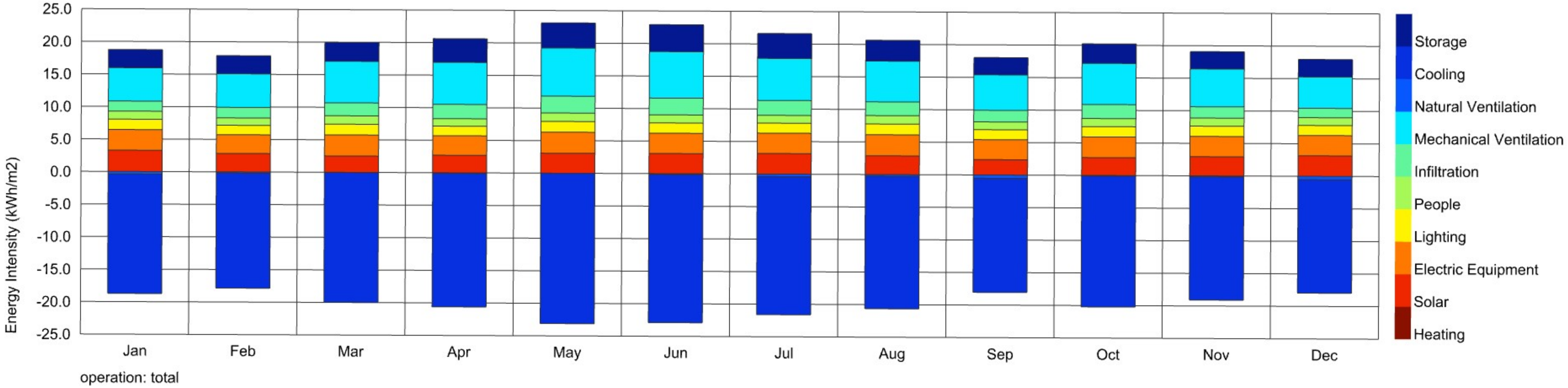
Final Model Simulation Results

Energy Usage (EUI Heating / Cooling)

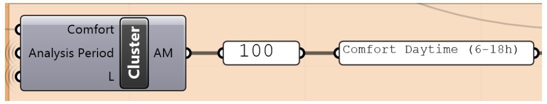
During peak summer the buildings Energy Usage has been more than halved and has been significantly cut during the winter months. All while achieving 100% daytime comfort throughout the whole year, something the baseline was not able to achieve. The baseline results are shown to the right for comparison.



Baseline EUI



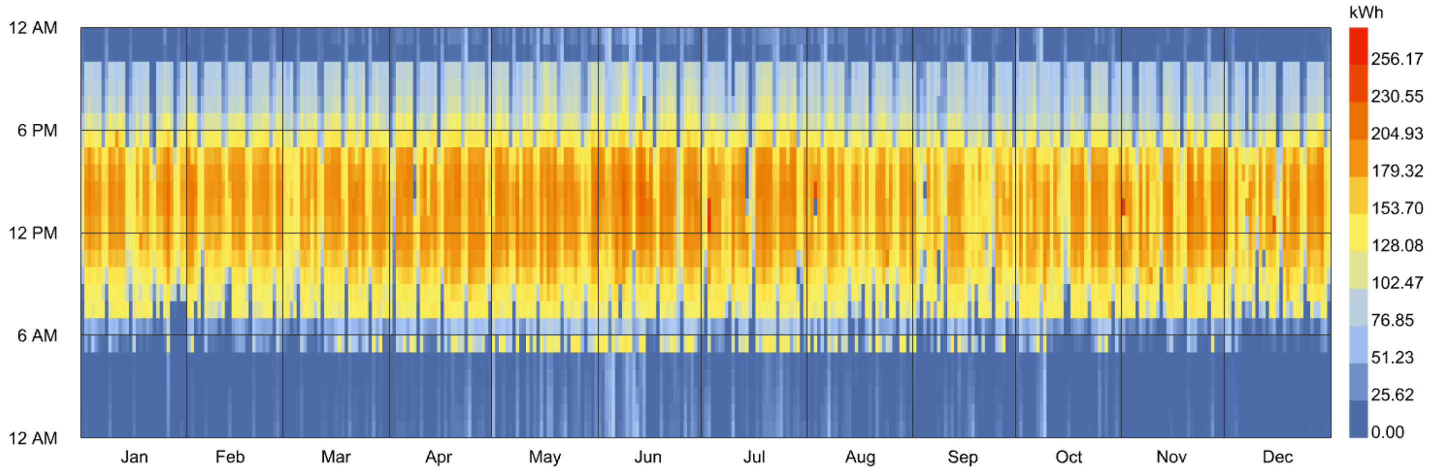
Final Model EUI



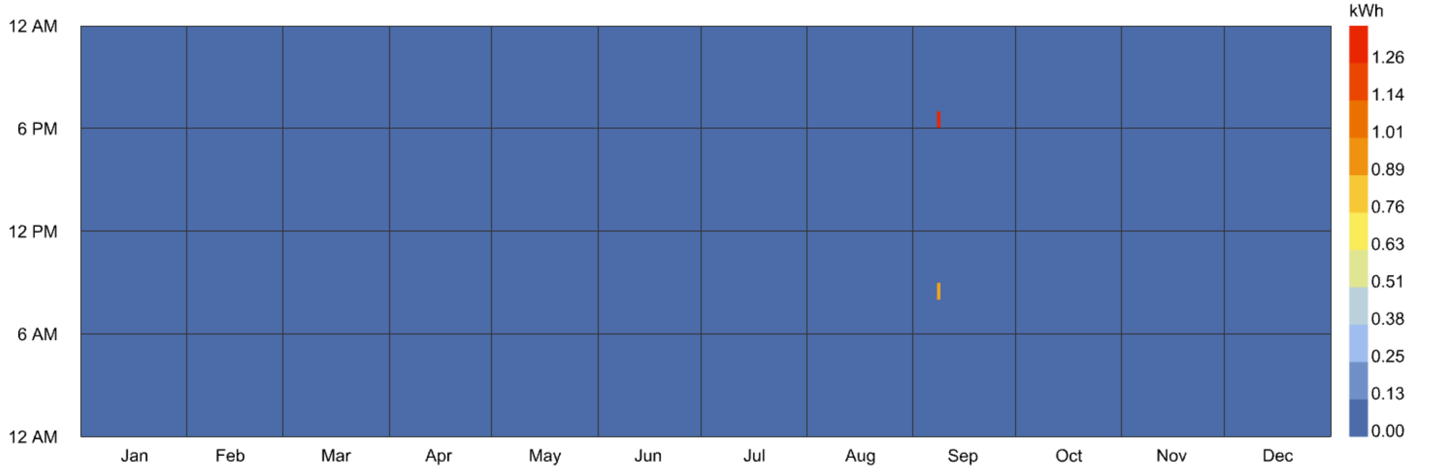
Final Model Daytime Comfort

Final Model Simulation Results

Energy Usage (EUI Heating / Cooling)

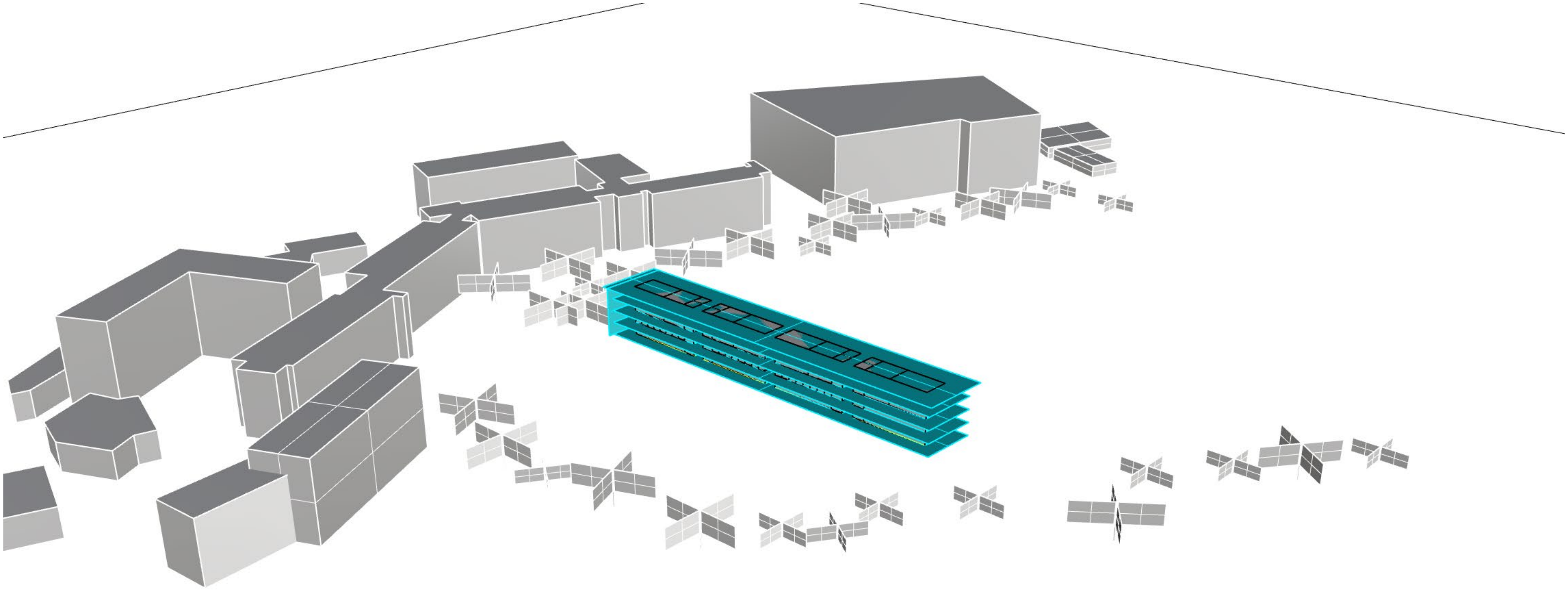


Energy (kWh)
1/1 to 12/31 between 0 and 23 @1
type: Cooling



Energy (kWh)
1/1 to 12/31 between 0 and 23 @1
type: Heating

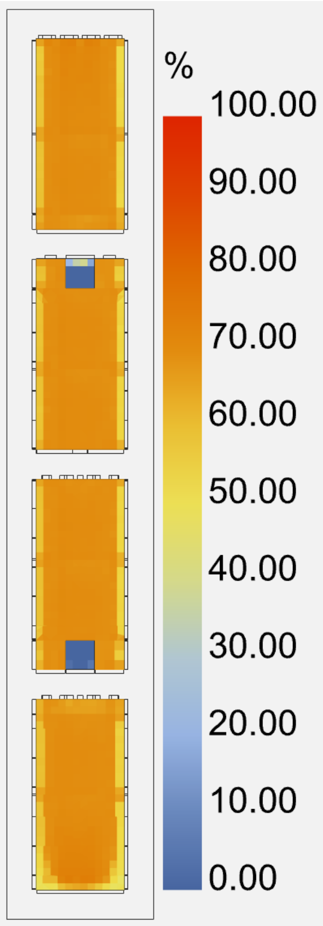
1st Iteration



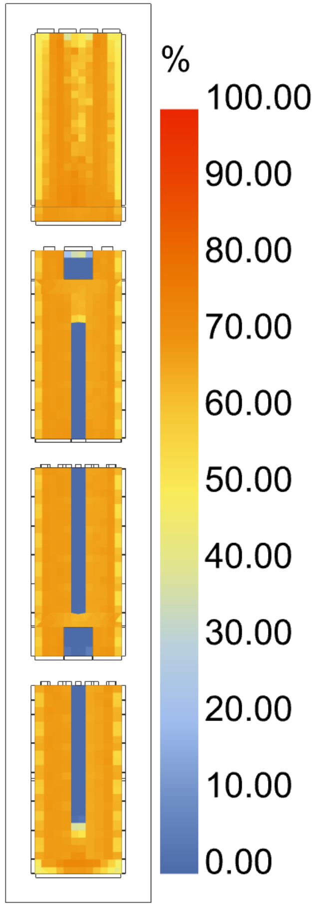
1st Iteration

sDA

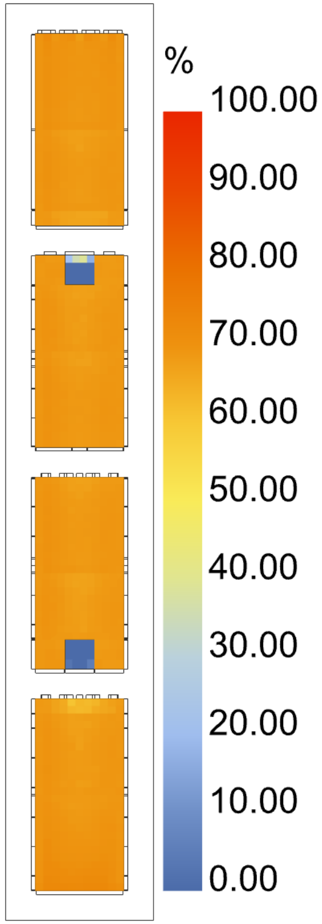
These simulations highlight the sDA issues that some larger rooms lacked daylighting in the middle. Also the hallways connecting the individual offices has little to no daylighting available.



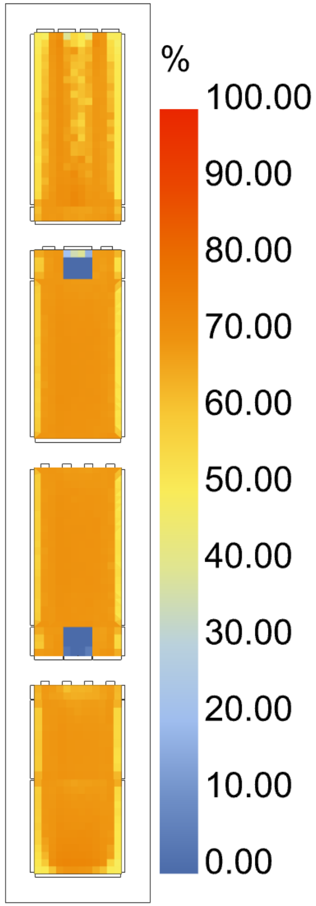
Ground Floor



1st Floor



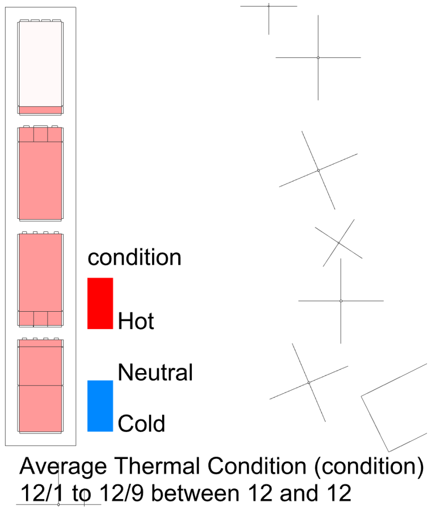
2nd Floor



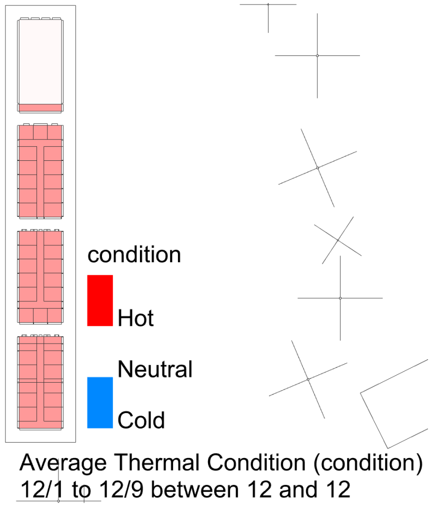
3rd Floor

1^{st} Iteration
Thermal Condition

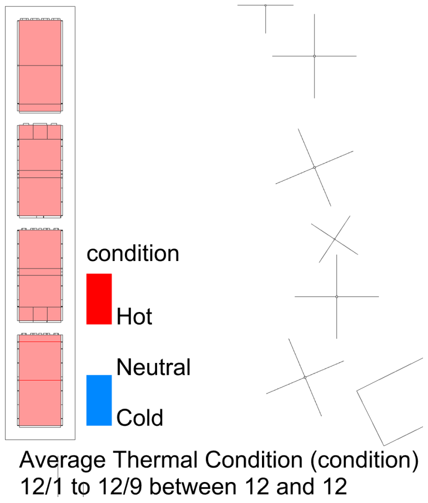
Even with the AC on the 1^{st} iteration of the building was unable to keep the rooms within the neutral thermal condition



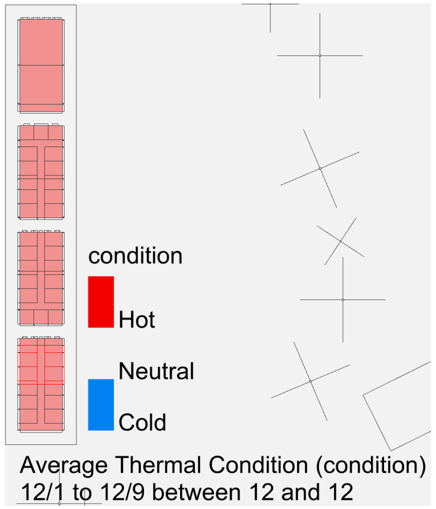
Ground Floor



1^{st} Floor



2^{nd} Floor

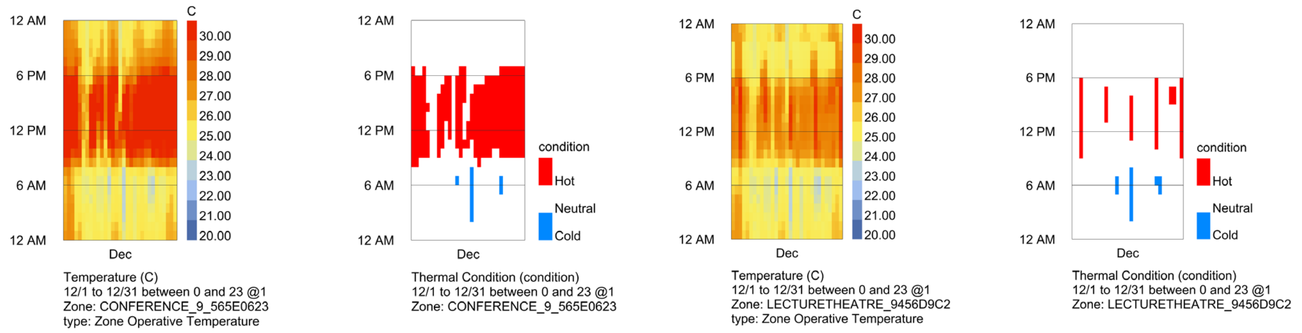


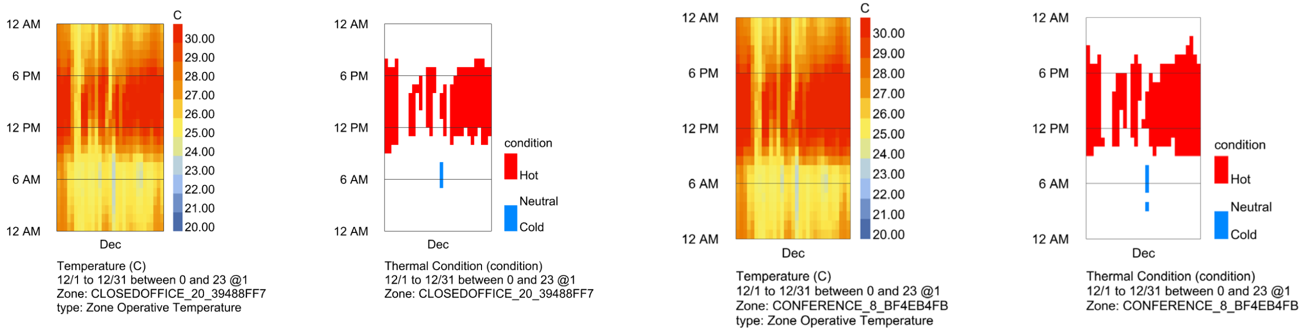
3^{rd} Floor

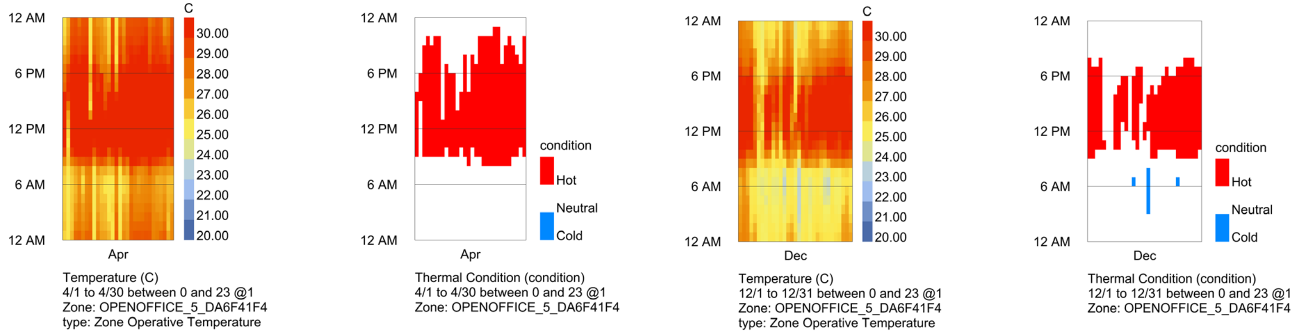
1st Iteration

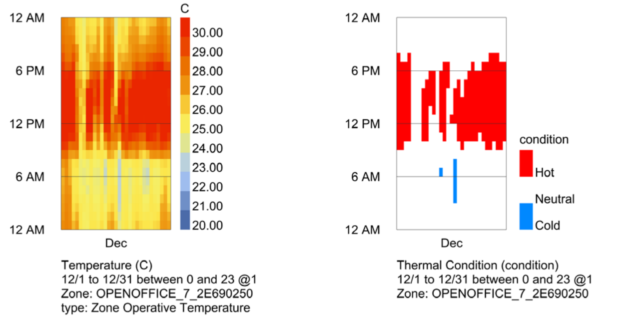
Zone Operative Temperature

Within most of the measured rooms the thermal condition was too hot for most of the day, even during the winter months.



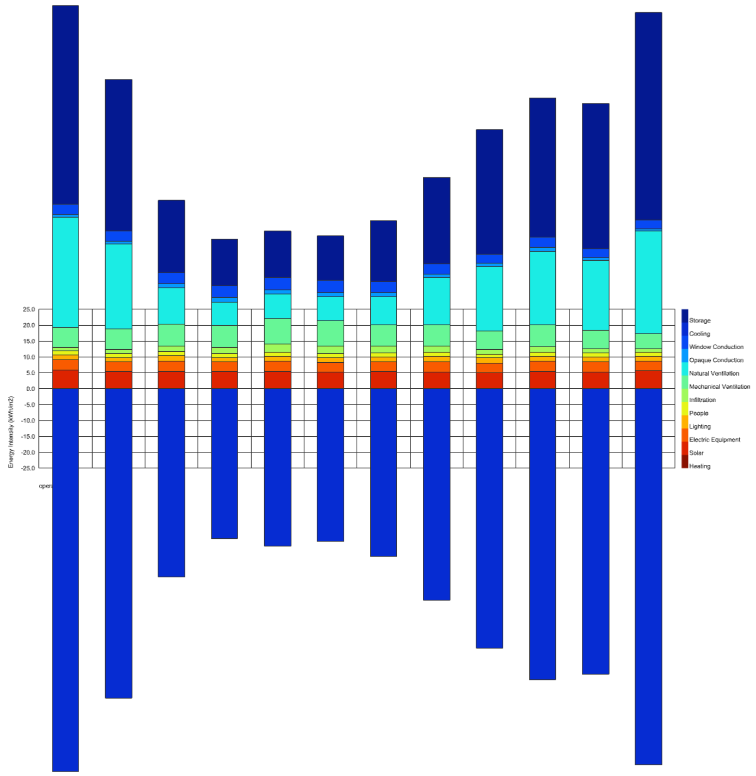


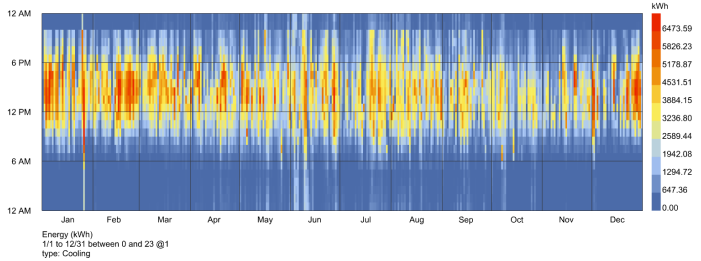


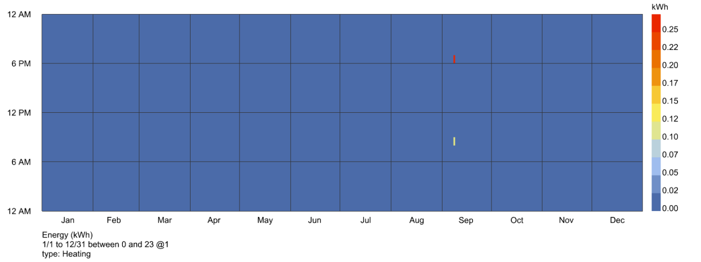


1st Iteration
Energy Usage (EUI Heating / Cooling)

This poor performance of the first iteration is continued into the EUI simulation where the building performed worse than the baseline.

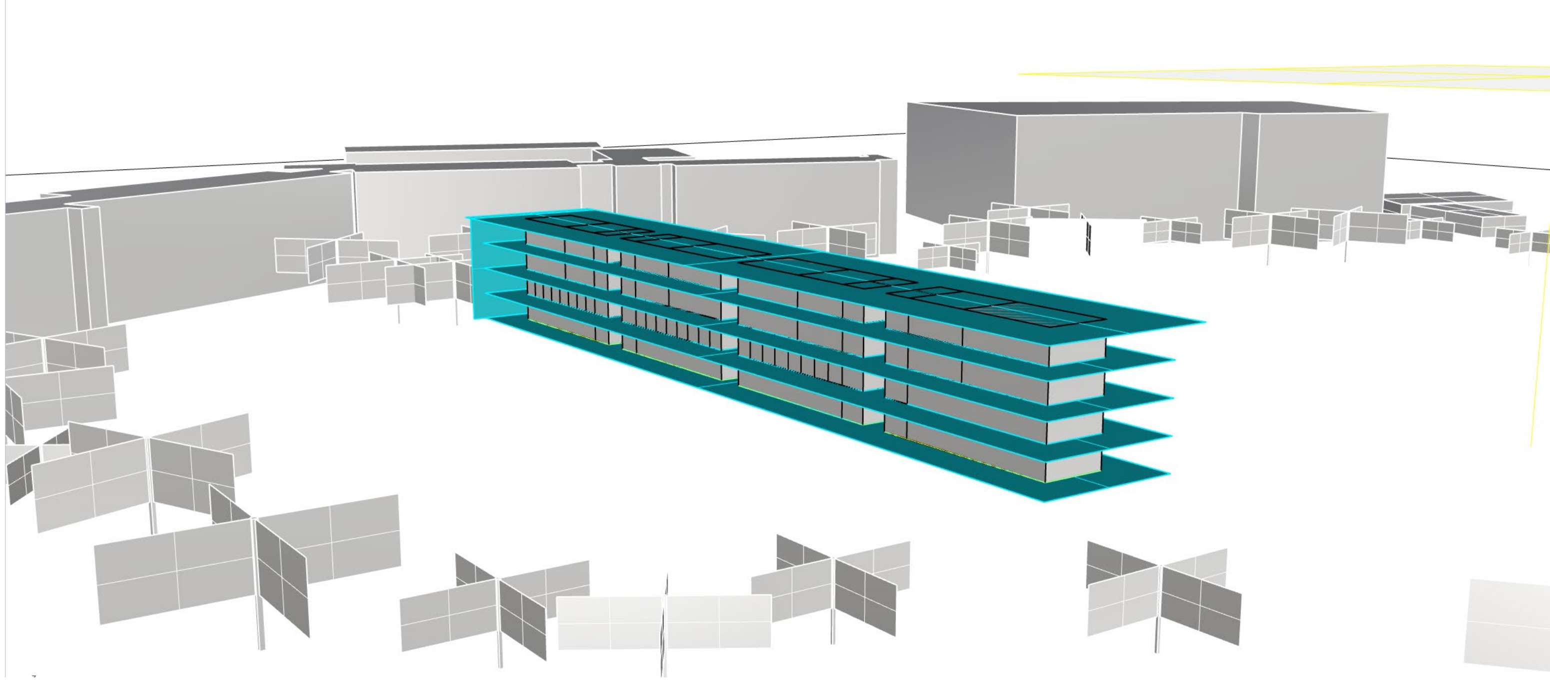






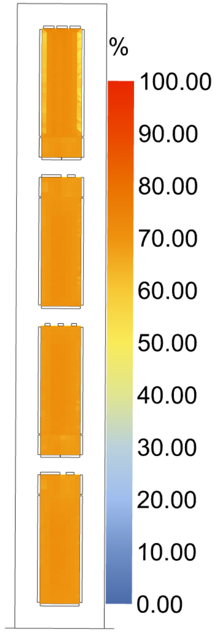
2nd Iteration

The second iteration of the design made improvements by reducing the overall width of the building form 12m to 8m, removing all internal circulations and general improvements to the layout.

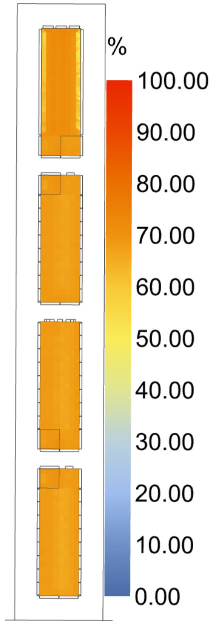


2nd Iteration
sDA

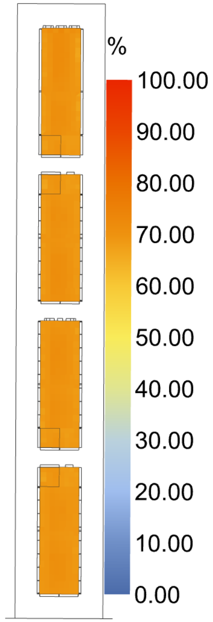
The reduction of the overall building width and the removal of internal circulation has had a significant impact on the sDA simulation results. The entirety of the floor plan not receives an optimal among of daylighting.



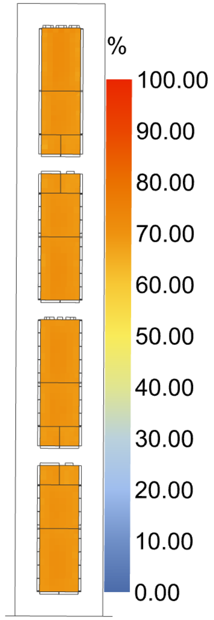
Ground Floor



1st Floor



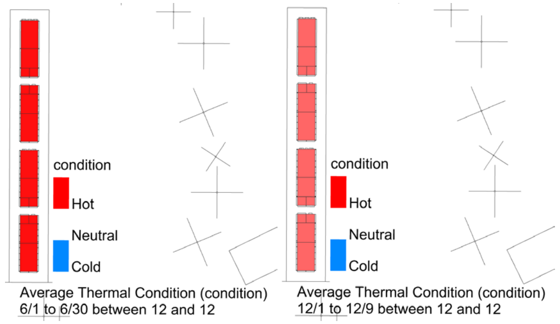
2nd Floor



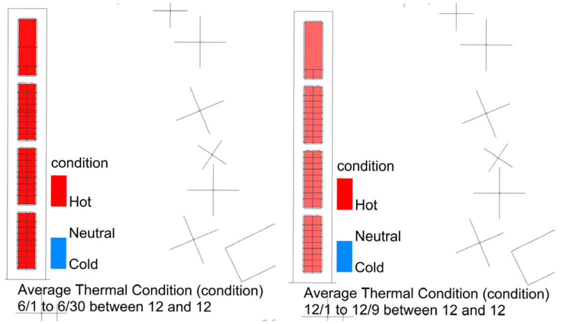
3rd Floor

2nd Iteration
Thermal Condition

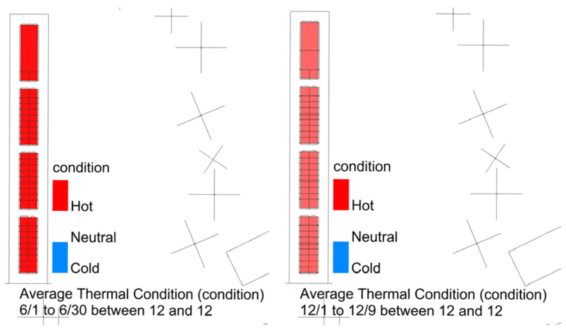
- Analysis of simulations
- Improvements to the design



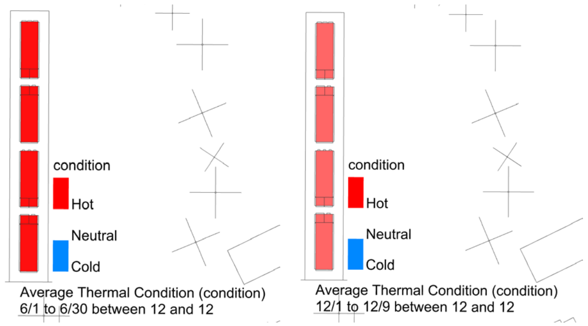
Ground Floor



1st Floor



2nd Floor

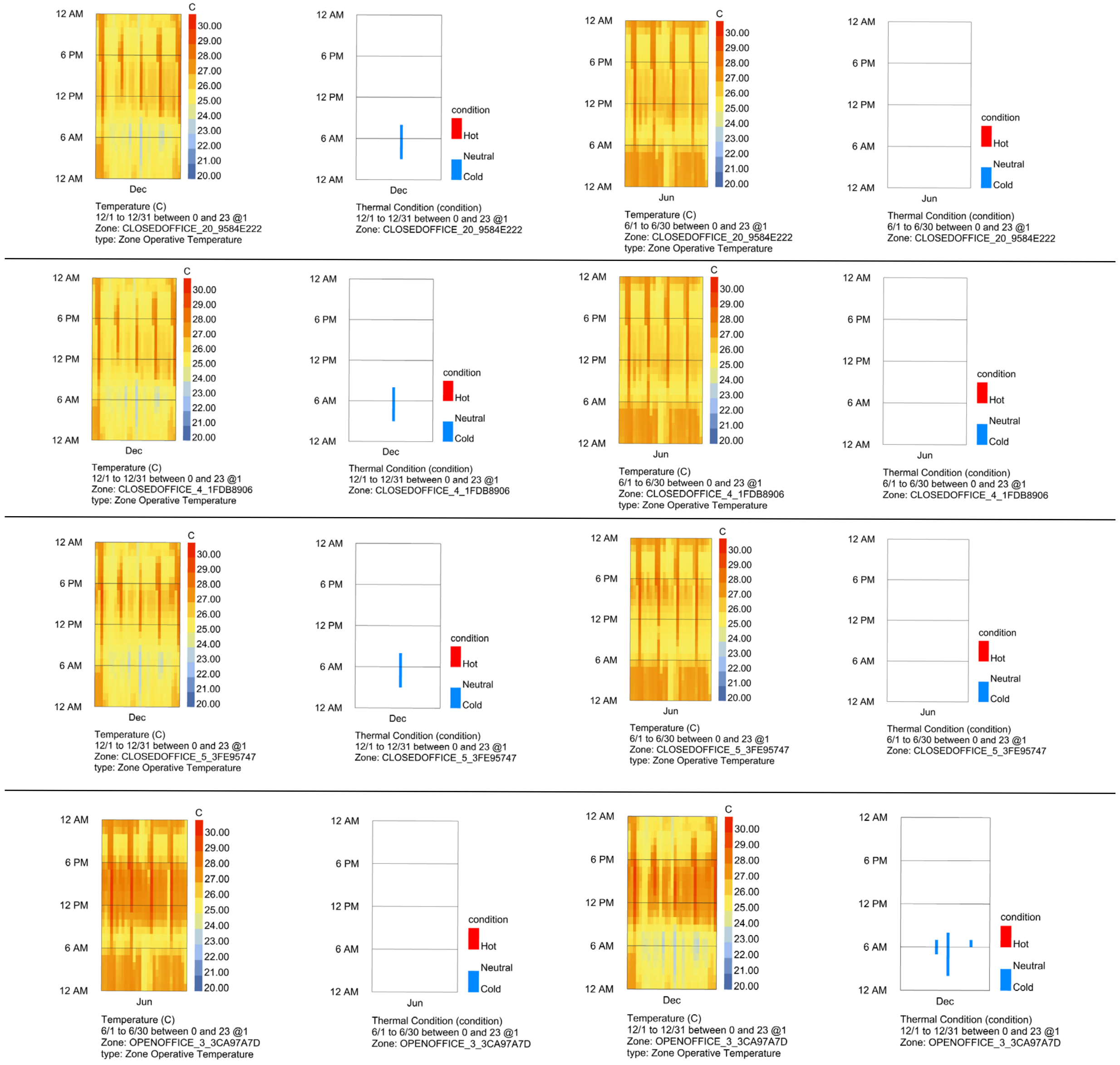


3rd Floor

2nd Iteration

Zone Operative Temperature

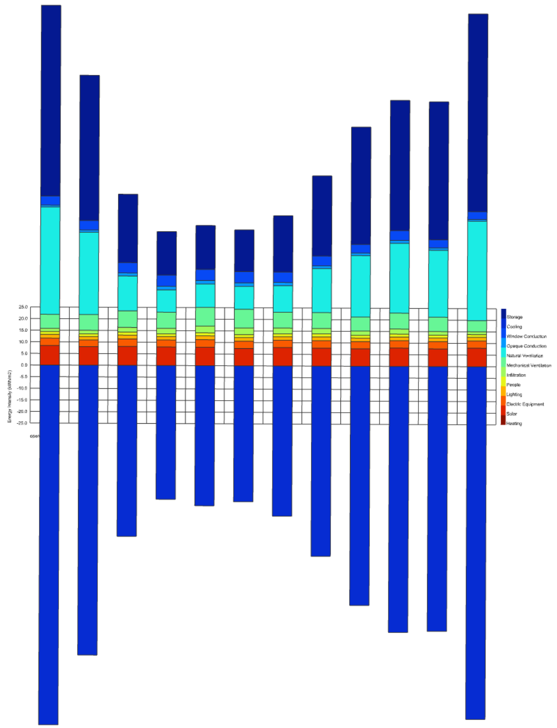
The AC is now able to keep the building within the neutral thermal condition. However, a lot of the rooms are running much hotter than what is ideal and the building is using a lot of energy to maintain is comfort level as seen on the next slide.

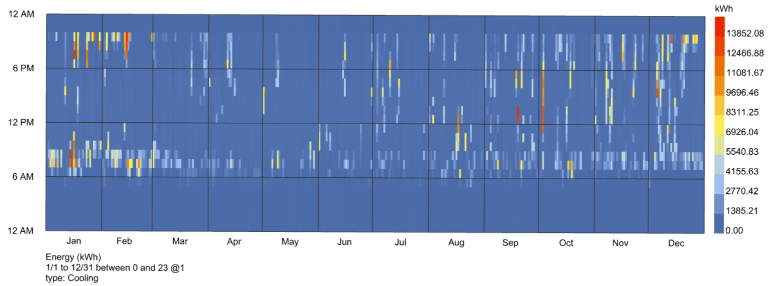


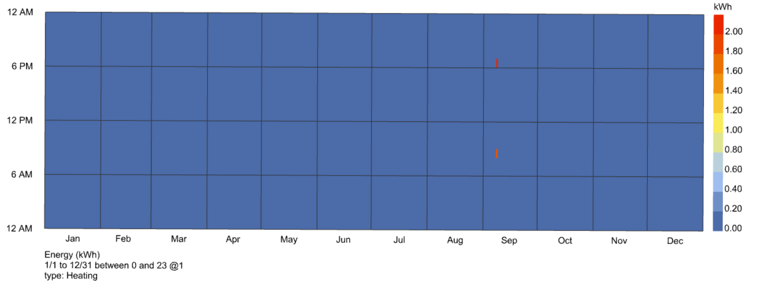
2nd Iteration

Energy Intesity (EUI Heating / Cooling)

Whist the 2nd iteration was able to improve on some of the issues with the initial design. This EUI simulation clearly shows that more is needed in order to bring the building within acceptable standards. More drastic measures will have to be made in the 3rd iteration of the design.

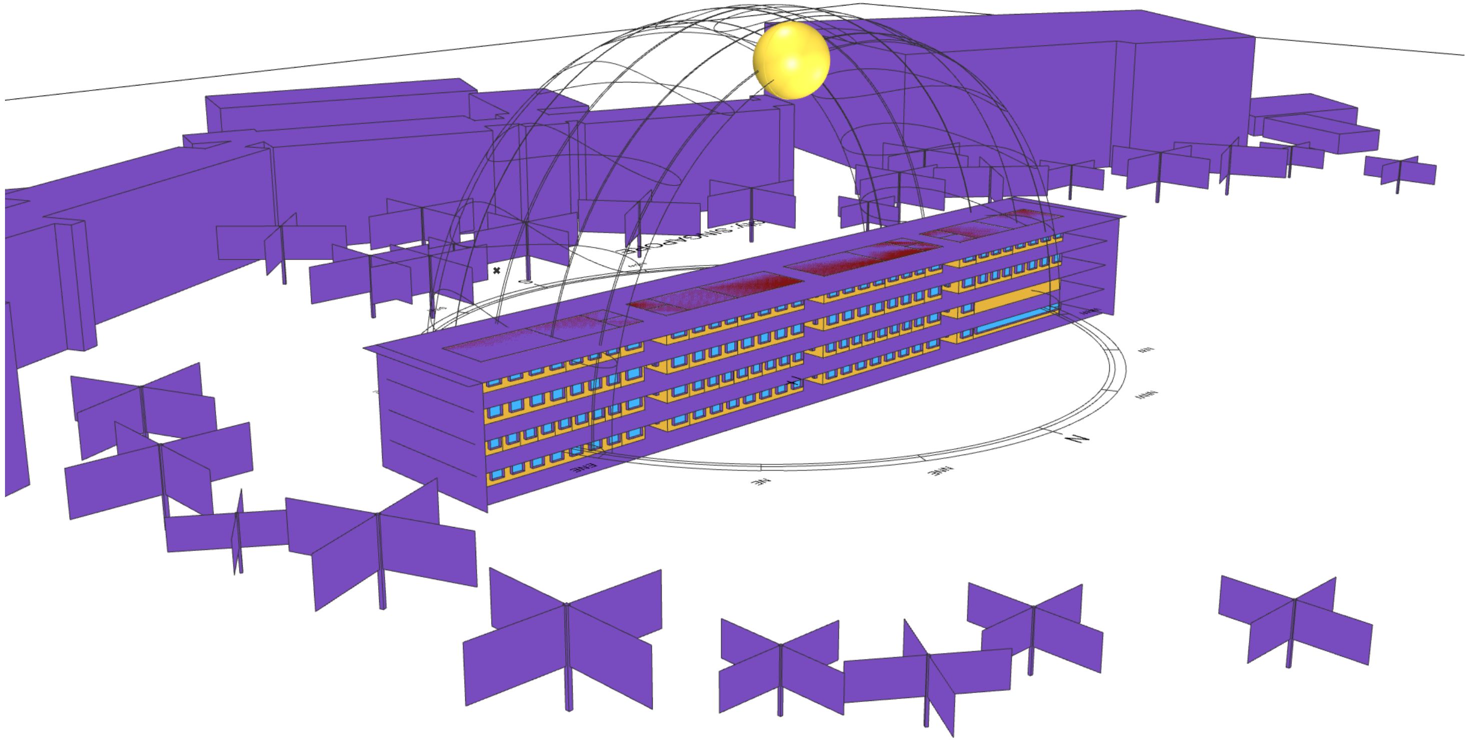






3rd Iteration

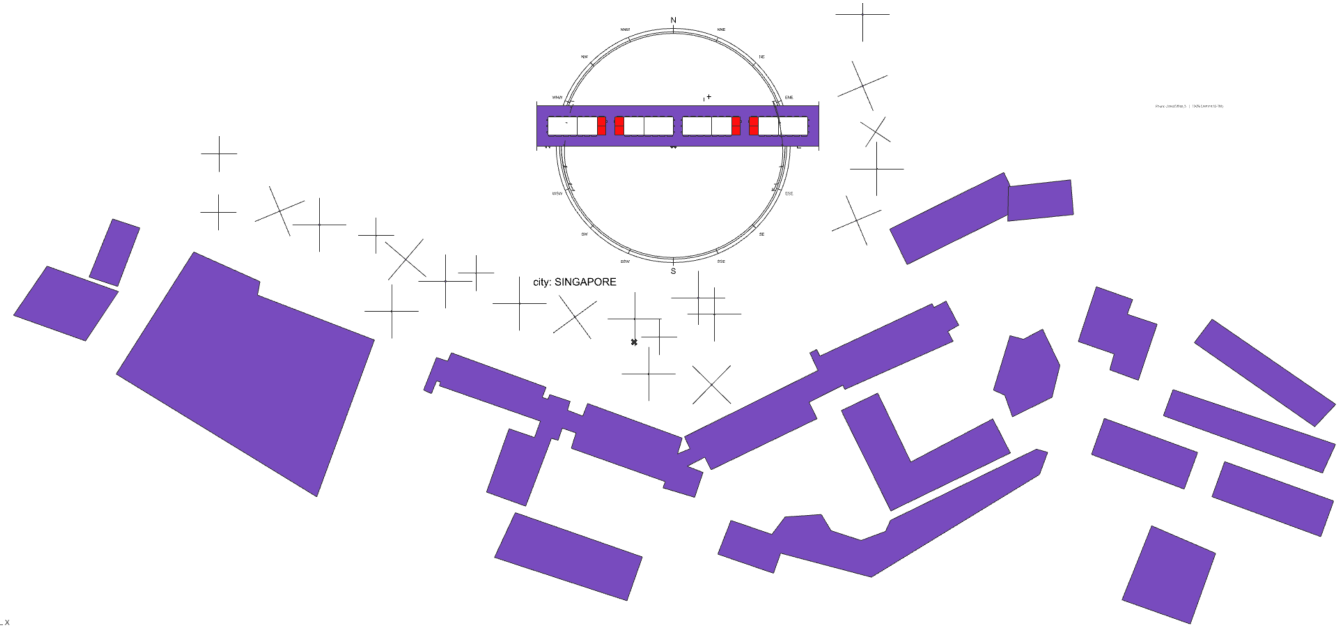
In order to improve the design of the building further some alterations had to be made. The buildings orientation was rotated 90 degrees so now the buildings long edges face north & south. In addition to this a new shading device was added to the eastern. The existing overhangs were also increased by 2m in all directions spanning out from the building. Finally, window sizes were also tested and adjusted.

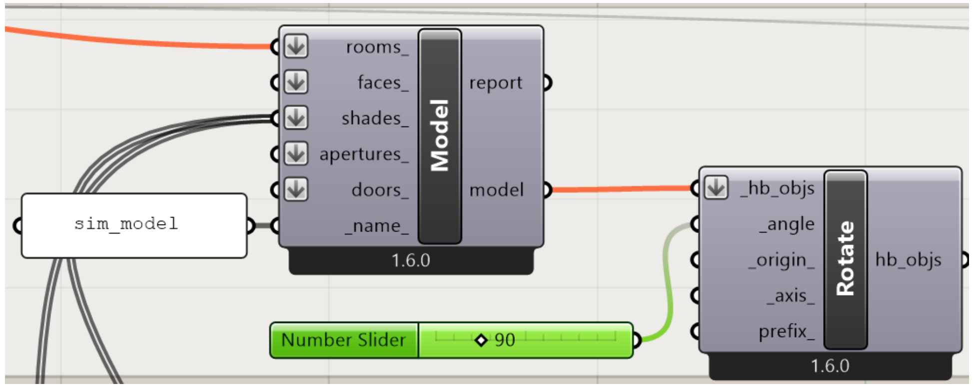


3rd Iteration

Model Rotation

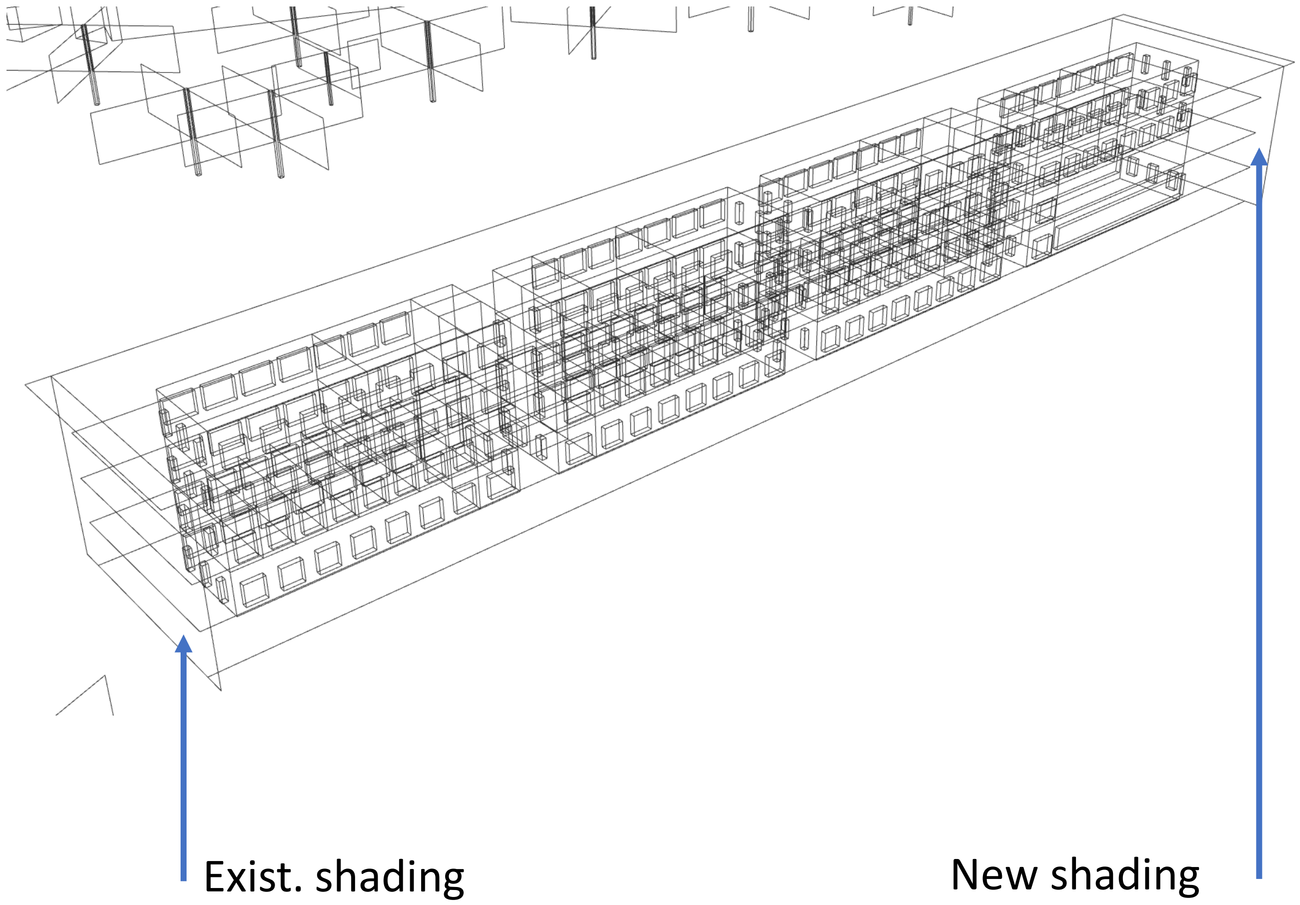
The buildings rotation was adjusted in order to protect the largest building facades from the sun. This also had an added effect of angling the building to take full advantage of the prevailing winds in Singapore.



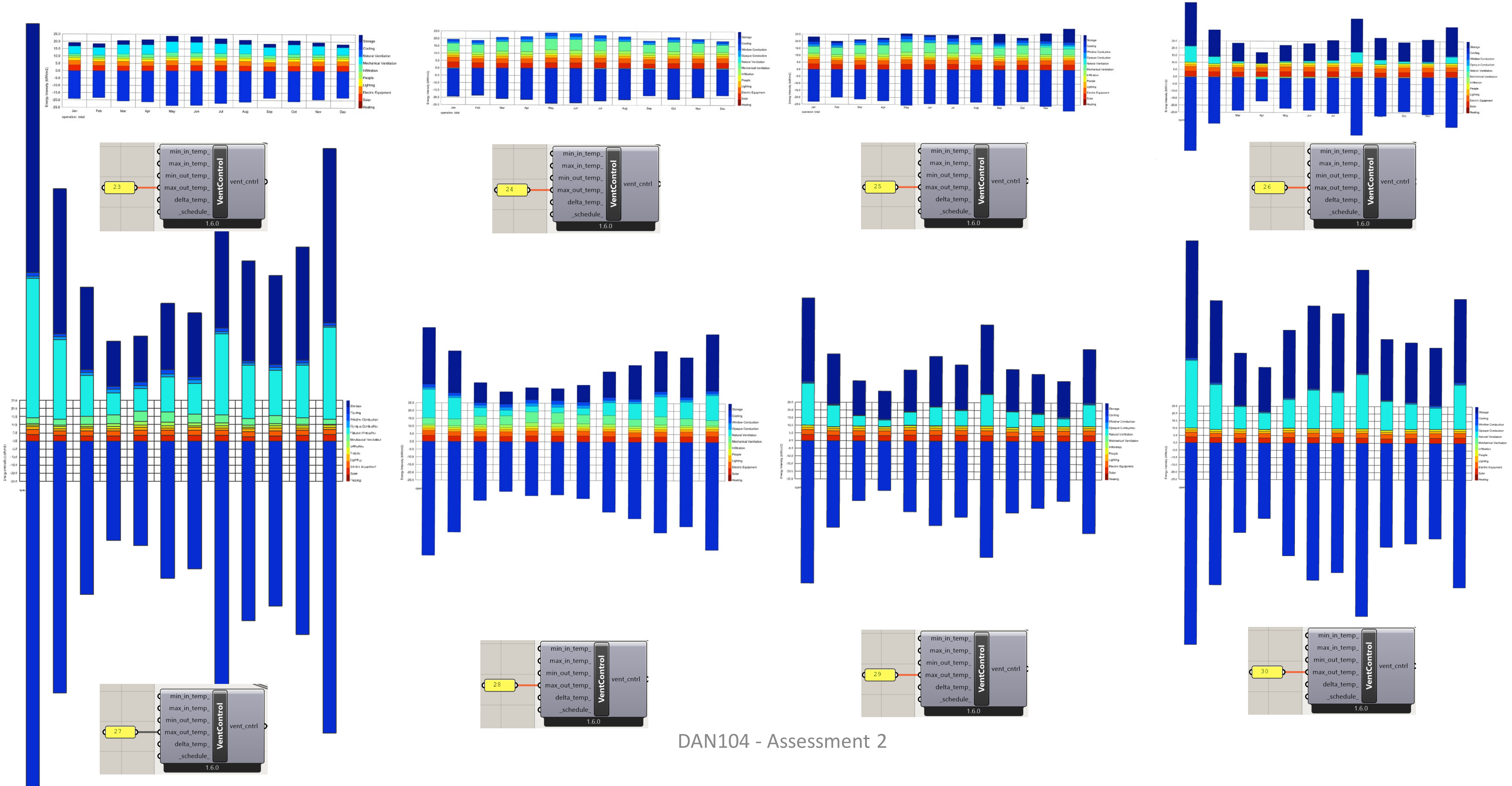


3rd Iteration
Shading Adjustments

The additional vertical shading device is visible in the perspective view to the right.



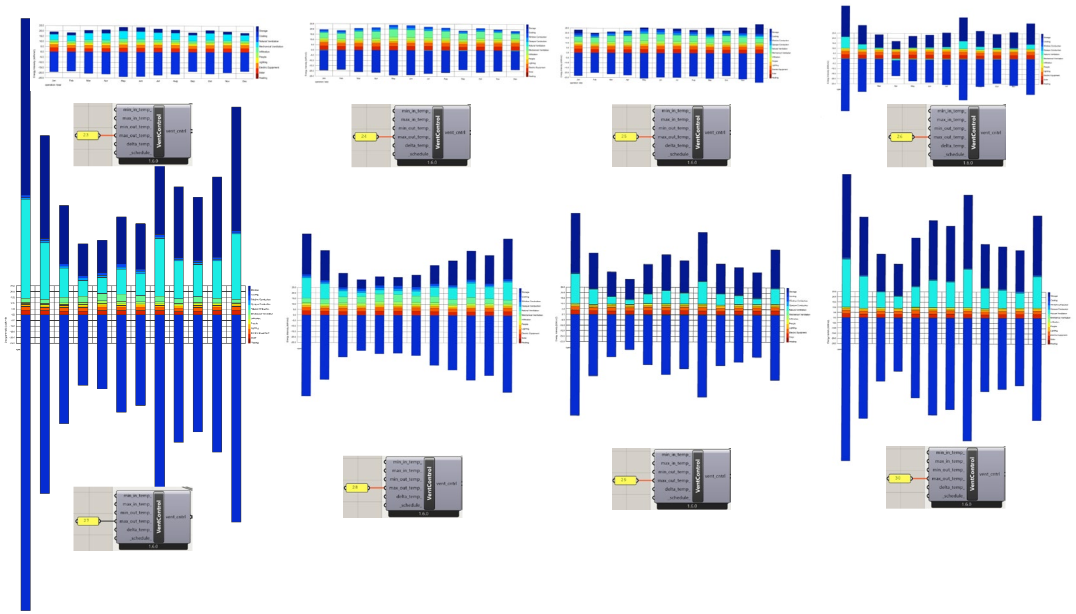
3rd Iteration
Testing max outside temperature vent control through energy intensity (EUI)



3rd Iteration

Testing max outside temperature vent control through energy intensity (EUI)

By adjusting the temperature input on the 'VentControl' node for 'max_out_temp' you can adjust the temperature at which the windows are closed, and cooling is switched to AC. This allows to natural ventilation to work at its maximum efficiency. In order to test this a wide range of temperature inputs was tested. Then the EUI simulation from these results was compared. EUI simulations were compared as it's the best way to compare the effectiveness of natural ventilation as well as the energy intensity of the AC. When looking at the results it is clear that a 'floor' is reached at roughly 24 degrees whereby any further lowering of the temperature has little to no effect of the results. This is why 24 was chosen in the final simulation model.

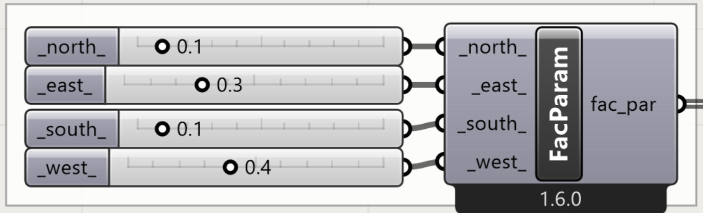


3rd Iteration

Testing max outside temperature vent control through energy intensity (EUI)

	N					E					S					W				
WINDOW RATIO	**0.9**	**0.7**	**0.5**	**0.3**	**0.1**	**0.9**	**0.7**	**0.5**	**0.3**	**0.1**	**0.9**	**0.7**	**0.5**	**0.3**	**0.1**	**0.9**	**0.7**	**0.5**	**0.3**	**0.1**
AVERAGE (sDA)	0.59663475	0.59672766	0.594048	0.575734	0.554828	0.820163	0.822063	0.817594	0.57252	0.195253	0.599377	0.592328	0.592587	0.57362	0.552209	0.73168	0.731633	0.723547	0.574884	0.368833
MODE (sDA)	0.5	0.5	0.5	0.5	0.5	1	1	1	0.5	0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0
MEDIAN (sDA)	0.5	0.5	0.5	0.5	0.5	1	1	1	0.5	0.071356	0.5	0.5	0.5	0.5	0.5	0.666667	0.666667	0.666667	0.5	0.375
STD DEVIATION (sDA)	0.25273802	0.24919487	0.253517	0.247523	0.237888	0.295036	0.292396	0.293832	0.244552	0.25041	0.254893	0.252066	0.250767	0.246524	0.236818	0.208407	0.210051	0.201497	0.246067	0.312354

Final Ratio Results	
AVERAGE (sDA)	0.642566
MODE (sDA)	0.5
MEDIAN (sDA)	0.5625
STD DEVIATION (sDA)	0.205575



In order to reduce the overall heat gain through windows the smallest window size needed to achieve the required sDA was tested. Through the results shown above the final window to wall ratio was selected.