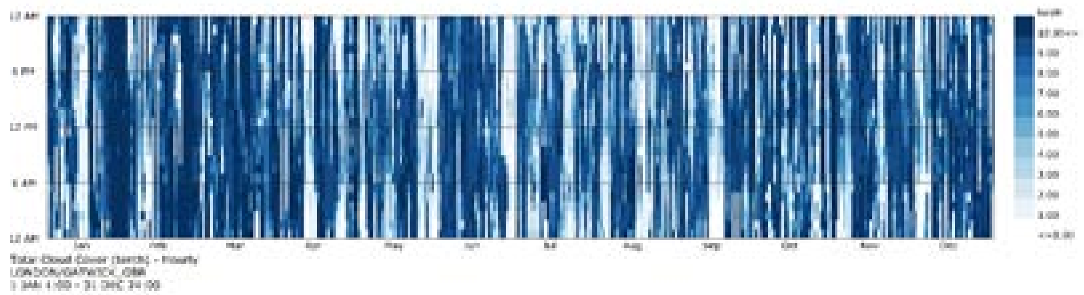
“It is not always sunny in London”

Knyazkina Ksenia

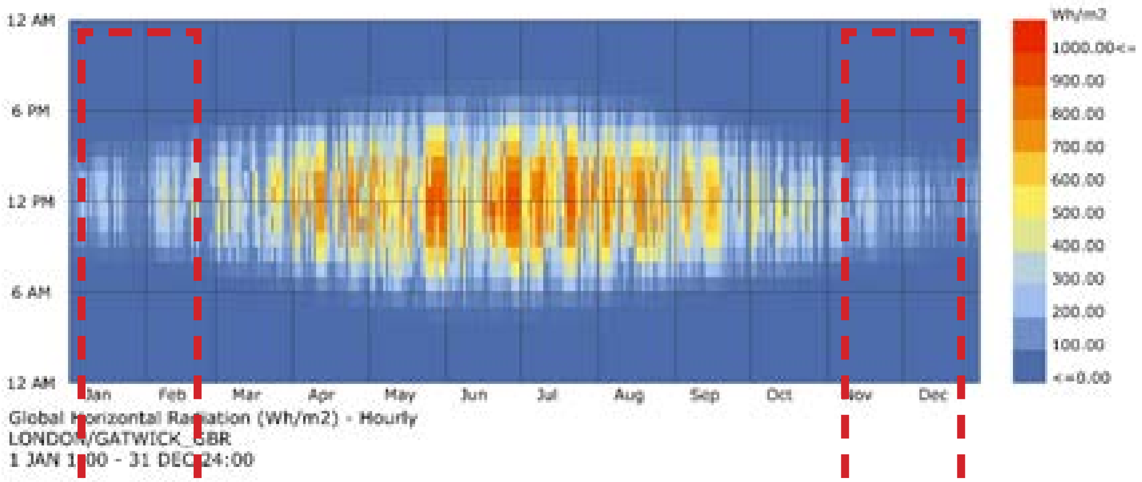
Building Performance Simulation

CLIMATE ANALYSIS - London

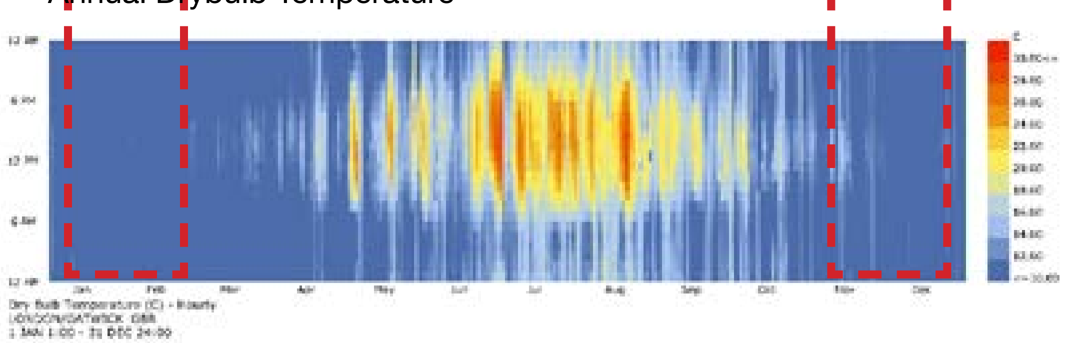
Cloud Coverage



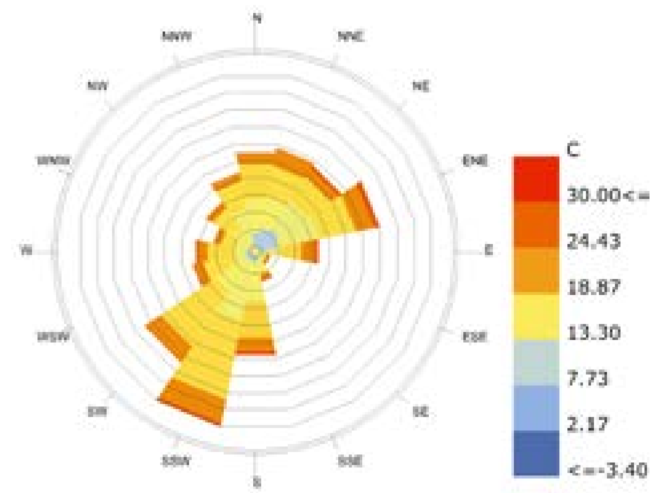
Annual Global Horizontal Radiation



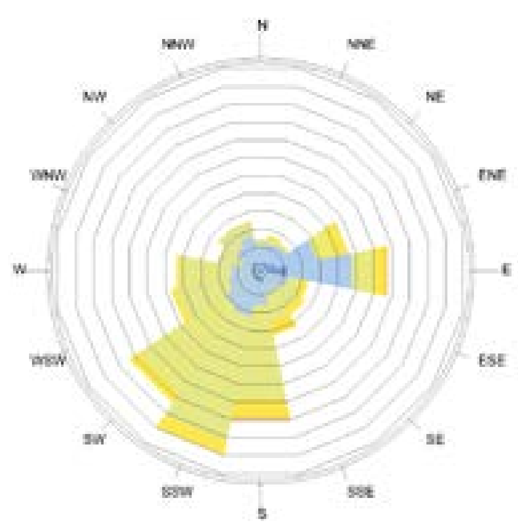
Annual Drybulb Temperature



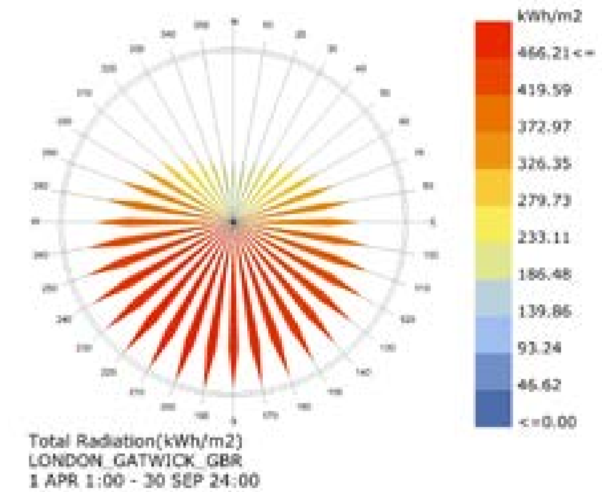
Summer wind rose



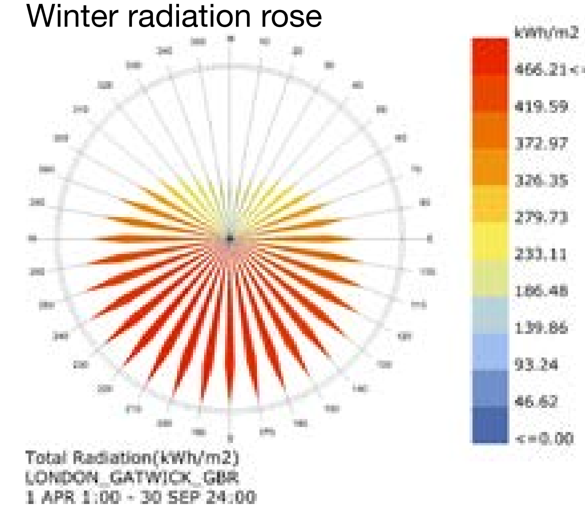
Winter wind rose



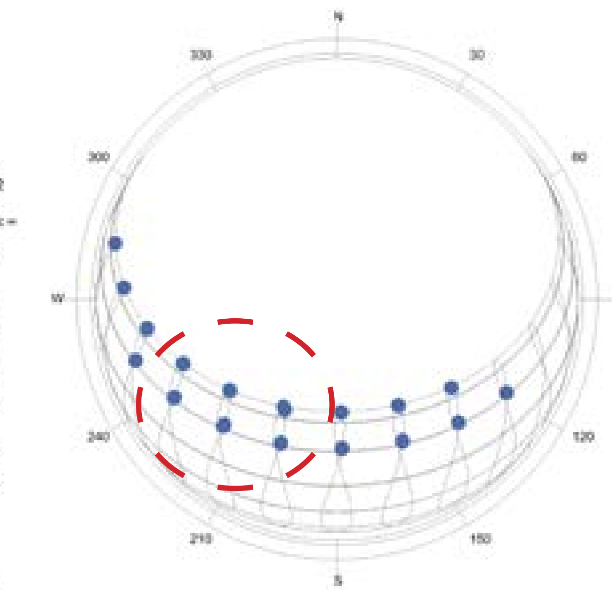
Summer radiation rose



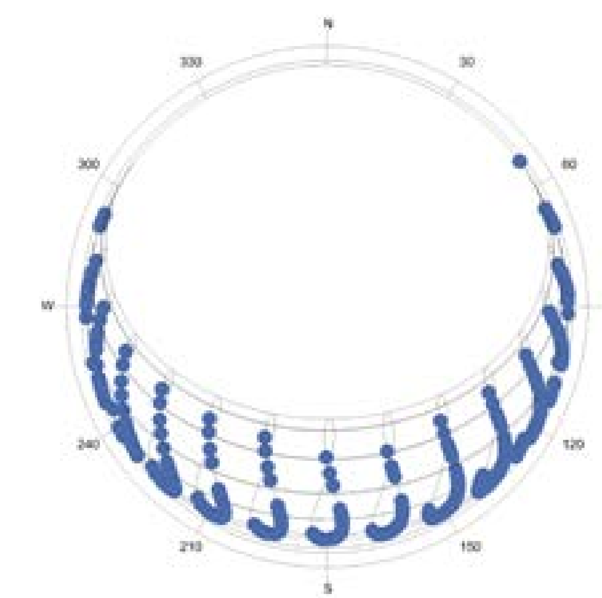
Winter radiation rose



Sunpath with hot hours



Sunpath with cold hours



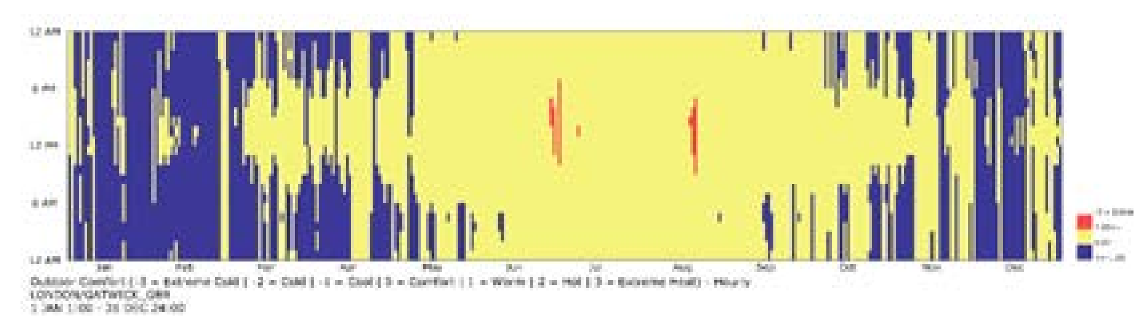
Temperature during the year is relatively low, which make it almost impossible to completely avoid usage of system. As it can be seen on the Global Horizontal Radiation and Dry Bulb Temperature graphs, January and December are most problematic period since temperature is lower than 10C and there is almost no solar radiation - the source of passive heating. It is also cloudy during the whole year, so the only way to gain sufficient amount of solar gains for passive heating is to create as bigger windows as possible , and use thermal mass to collect and store that heat.

Radiation roses for summer and winter show that bigger amount of radiation comes from south, which is most important fact for orientation in this case.

Warm wind in summer also comes from south/southwest.

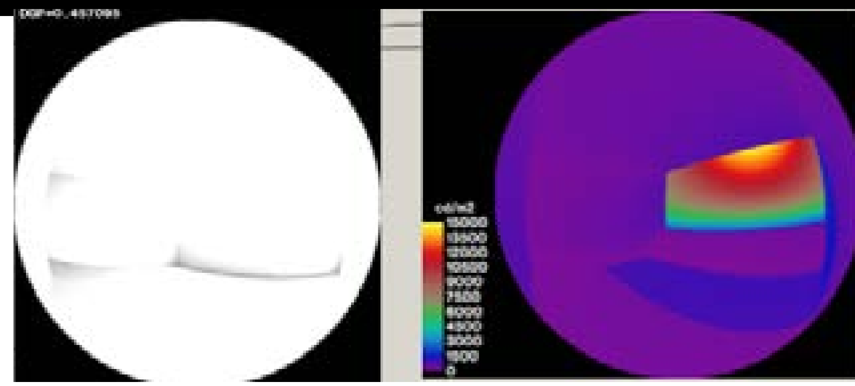
Sun Paths with mapped cold and hot hours show that overheating could be caused by west-summer-evening sun

UTCI during the year.



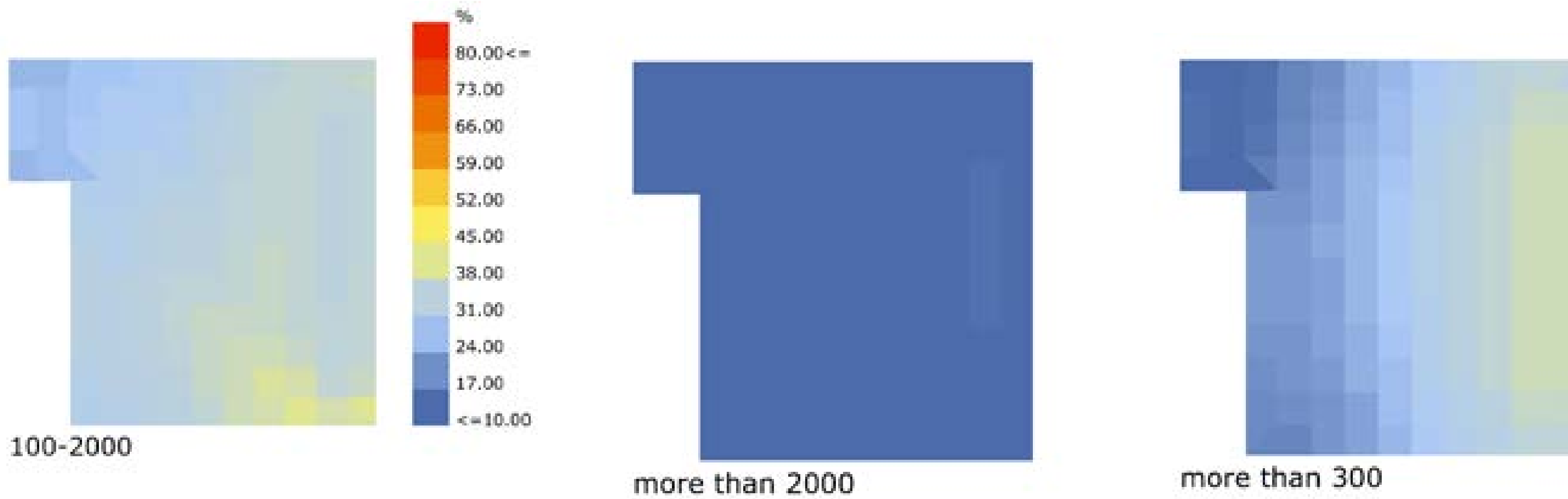
BASELINE

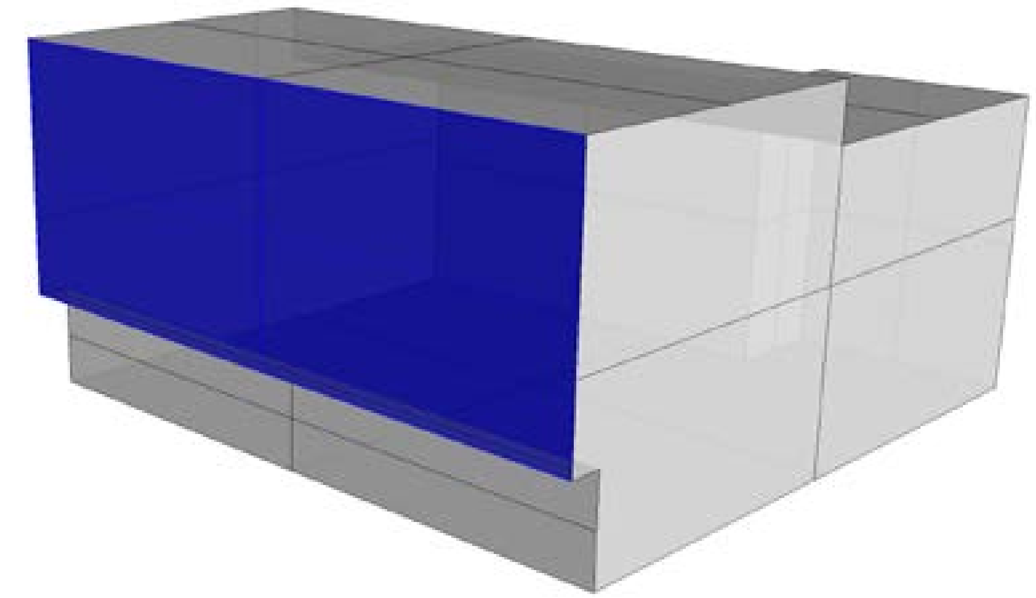
Baseline is simulated for following conditions: no system is used, all surfaces are either outdoor or ground, main facade facing southwest

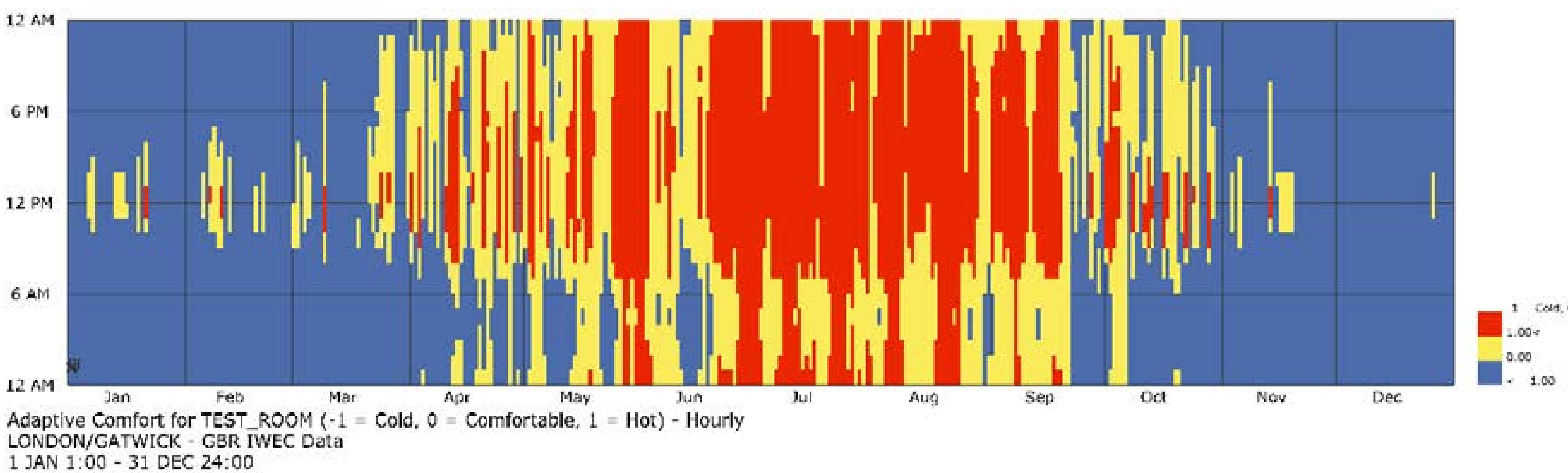


Glare analysis - DGP - 0.49

Daylight Autonomy







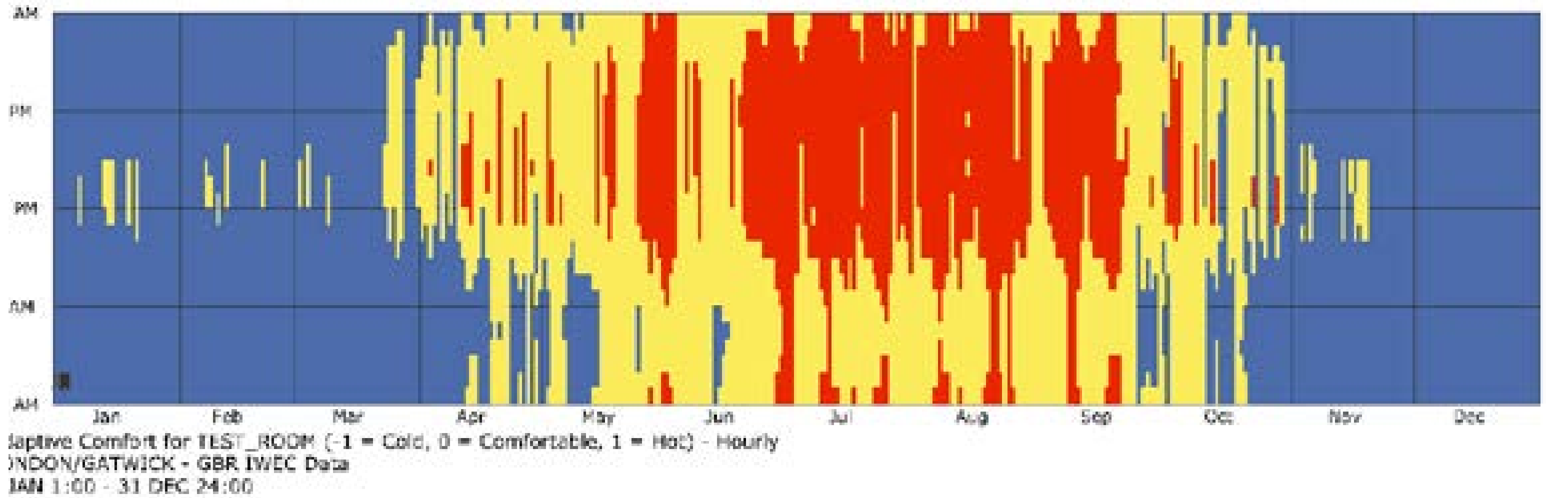
Annual Adaptive comfort - 25% with prevailing cold hours 51%

Cold hours is caused by lack of solar gains due to small window. Since the room in the baseline is not ventilated it led to the overheated hours. That can be solved with natural ventilation through the windows with assigning setpoints for minimum indoor temperature to and minimum outdoor temperature - to prevent inlet of cold air. Temperature inside is also changeable during the day, such fluctuations can be prevented by creating higher thermal mass

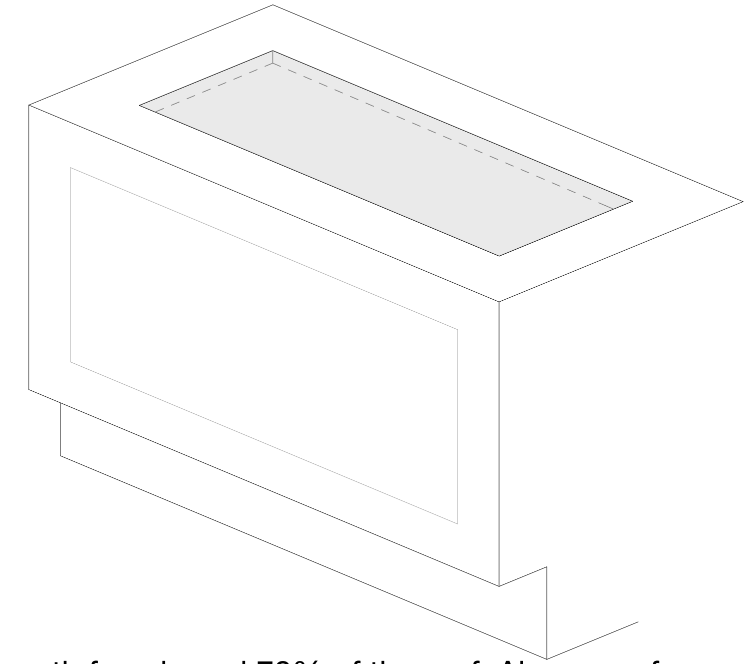
MATERIALS

GLAZING + VENTILATION

Adaptive comfort

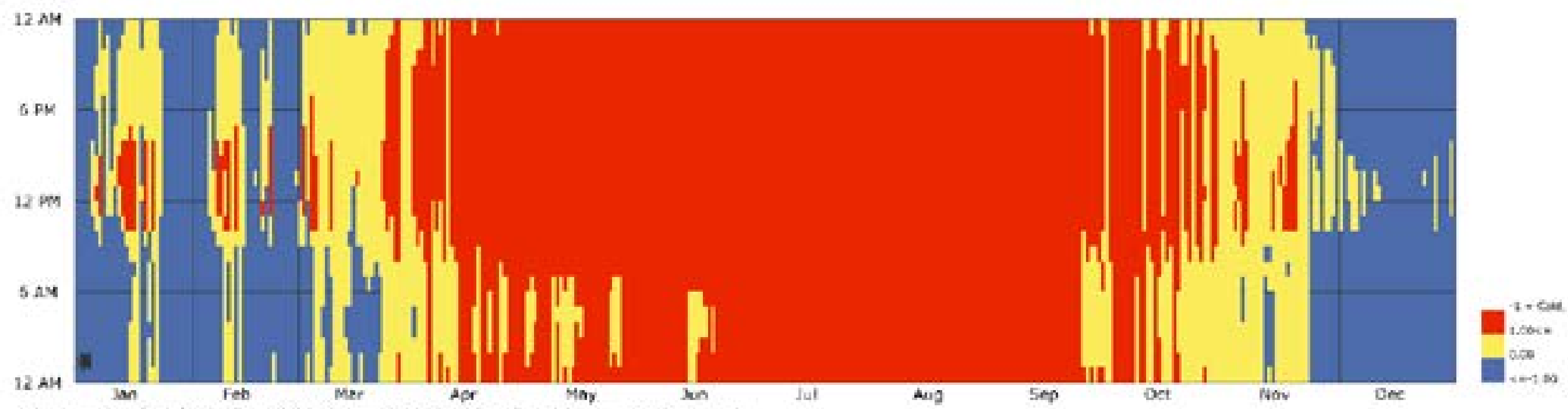


Glazing made the biggest difference in the reduction of cold hours. By “sensitive“ analysis was decided to use 50% of glazing in south facade, 70% in east facade and 50% of the roof.



32% of comfort hours and 47% of cold hours
Comfort hours with increased thermal masses on the south and north walls, and on the roof. Floor and east-west- facades are insulated. Number of warm hours increased comparing with baseline.

AdaptiveComfort hours with increased window area -80% on the south fasade and 70% of the roof. Absence of shadind resulted in the overheated hours. Comfort 22.6%. Cold hours 22.3%



MAIN STRATEGIES OF THE DESIGN:

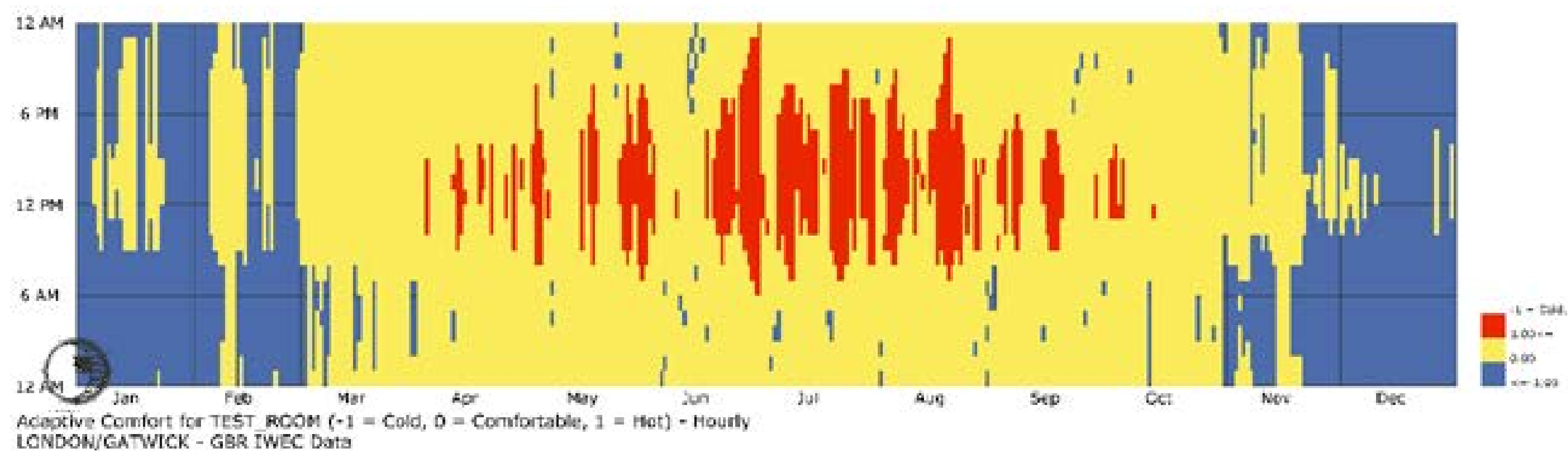
1. House is oriented to the south in order to receive maximum solar radiation.
2. Use thermal mass, insulation and glazing to let as much solar heat inside as possible, even though space will be overheated.
3. Reduce overheated and overlighted hours by shading, and facade rotation.

For thermal mass:
conductivity 0.5
thickness: 0.5 m
density: 1840
specific heat: 880

For insulation:
conductivity 0.025
thickness 0.08
density 40
specific heat 1300

At this stage of the design daylight and glare analysis were not simulated. Primary goal was to experiment with different passive heating strategies.

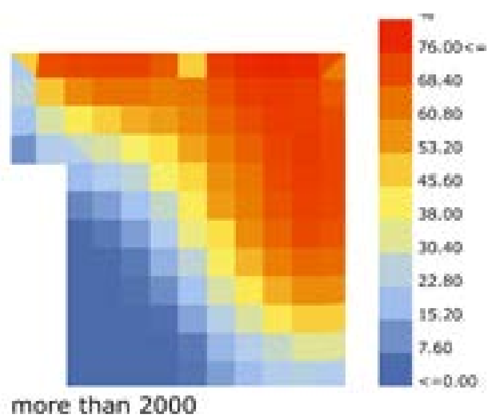
Adaptive comfort with natural ventilation. Minimum indoor temperature 24C. Comfort 65%. Cold hours 25%.

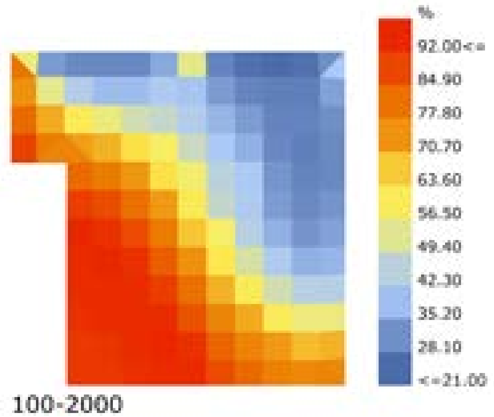


LOUVRES + OVERHANG

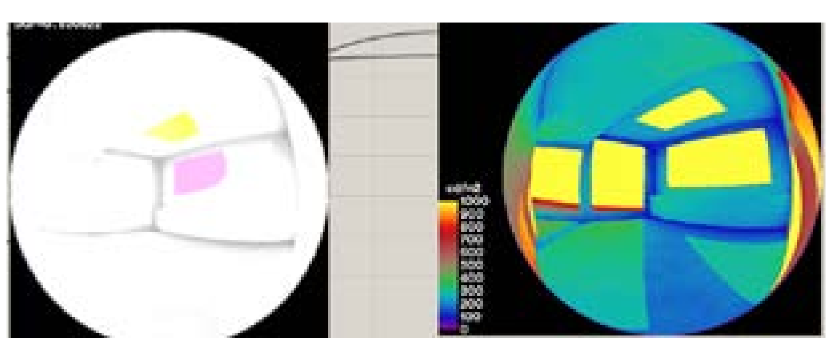
Daylight Autonomy without shading

Since glazing area is big there lack of light is not a problem in this case. Room was mostly overlighted with up to 0.8 DGP.





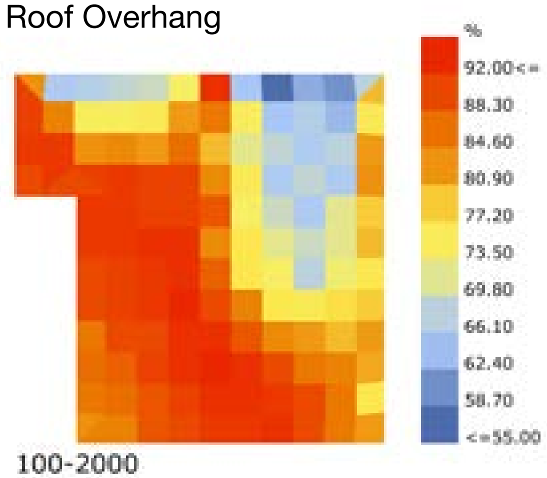
DGP 0.82 without shading



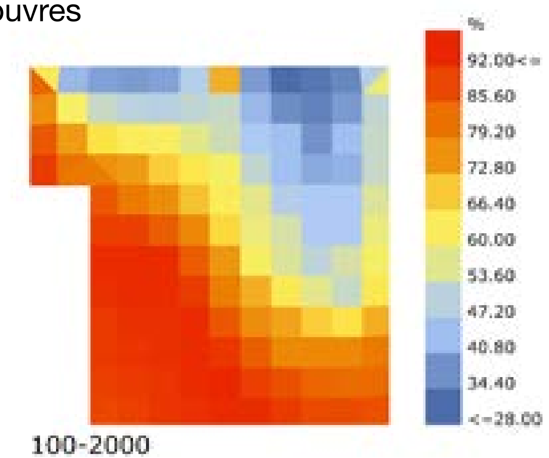
Daylight Autonomy with louvres (0.15 depth) and 1m roof overhang

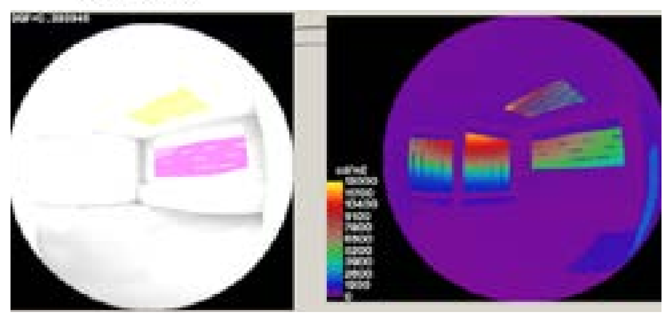
Due to different angles of the morning and afternoon sun shading for the east side was design vertical, and for south - horizontal.

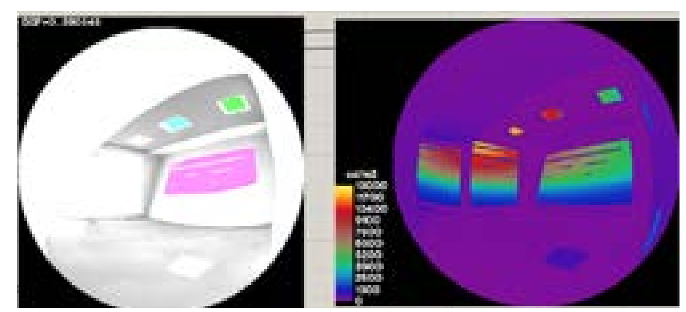
Roof Overhang



Louvres

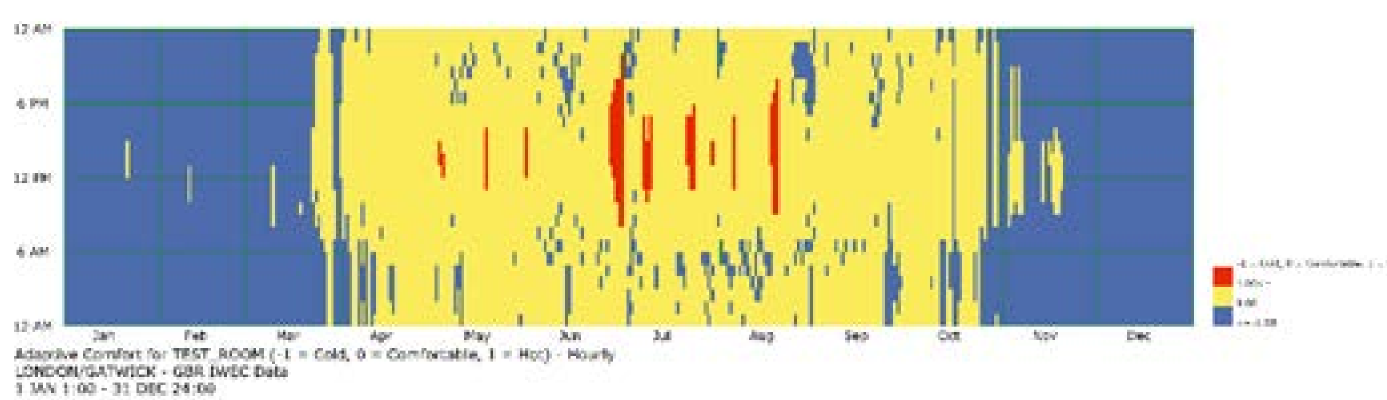






Adaptive comfort - 49%

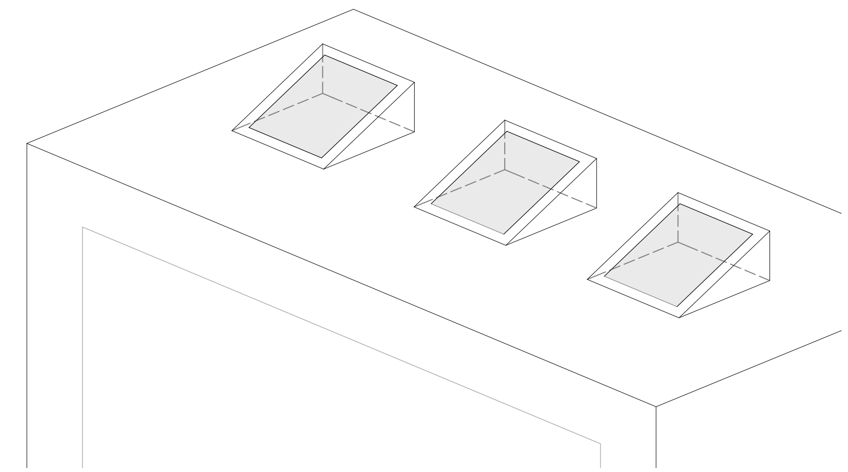
Even though daylight autonomy and glare improved with new louvres and roof overhang the design was not acceptable because of reduced comfort hours. Louvres blocked too much winter sun in resulted in increased cold hours.

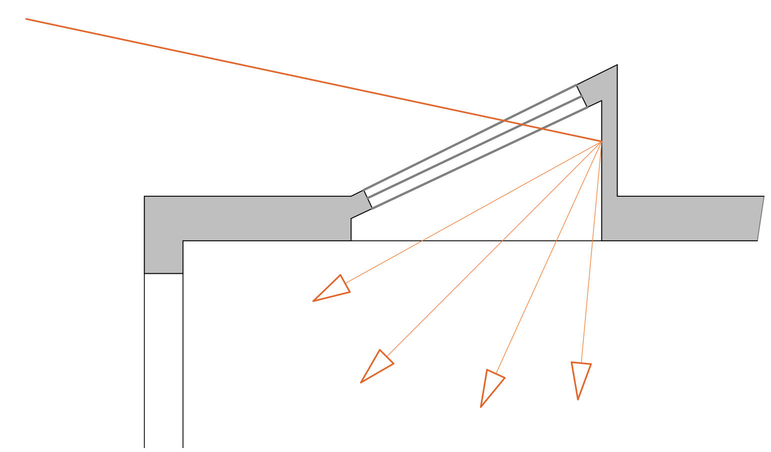


SKYLIGHT

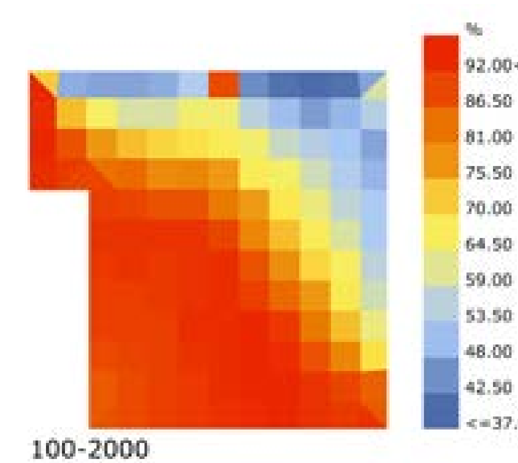
New skylight design

Simple flat skylight provide enough solar gains in the room, however, it required dynamic louvres to work properly and prevent overheating and glare. New design propose 3 smaller skylights which diffuse sunrays.

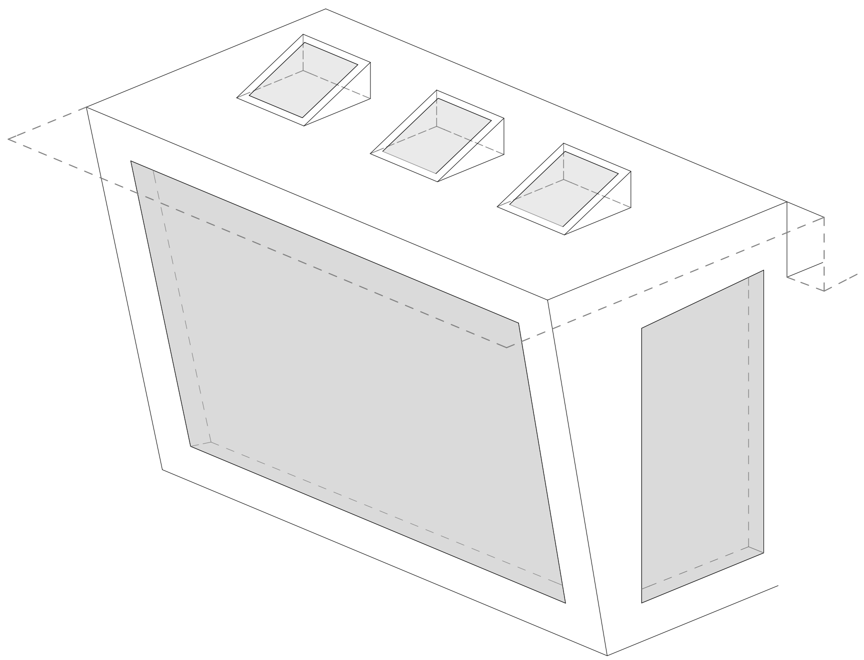




Daylight with new skylights

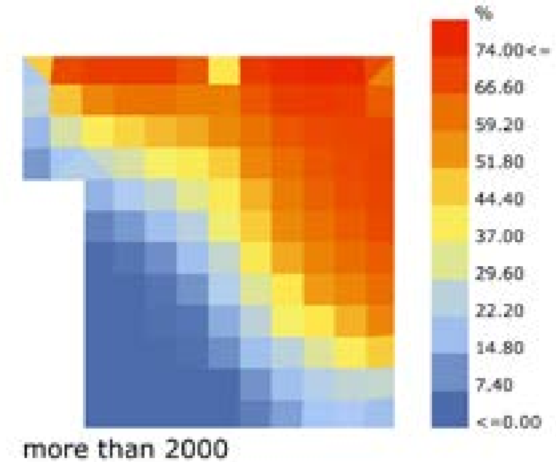


TILTED FACADE

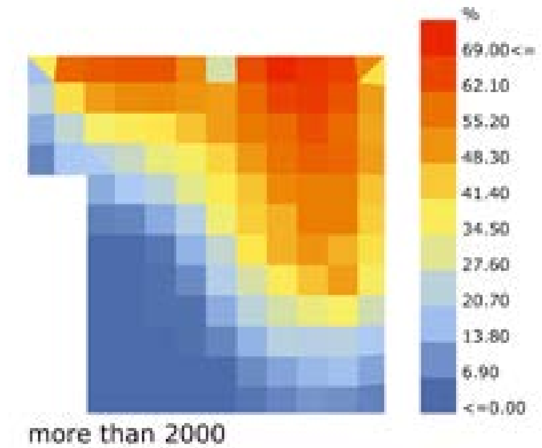


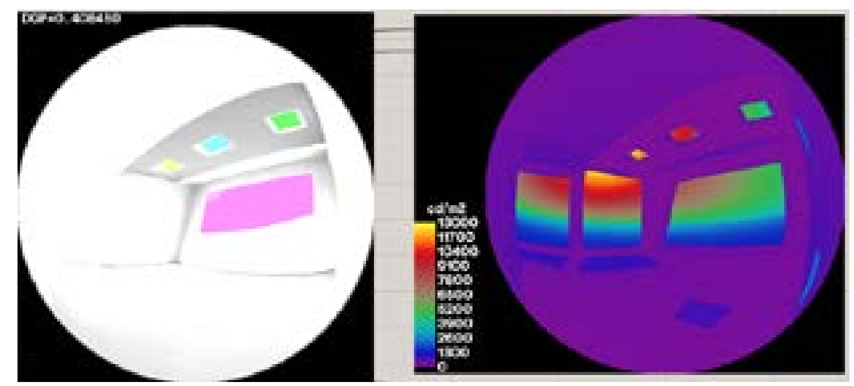
New tilted facade was designed together with new horizontal louvres. Tilted facade aims to let more winter sun, and prevent overheating by summer rays, providing enough radiation for passive heating, but blocking unwanted light. Also was designed roof overhang 1.5 m in depth.

Daylight with tilted facade.
The biggest percent of time 71%

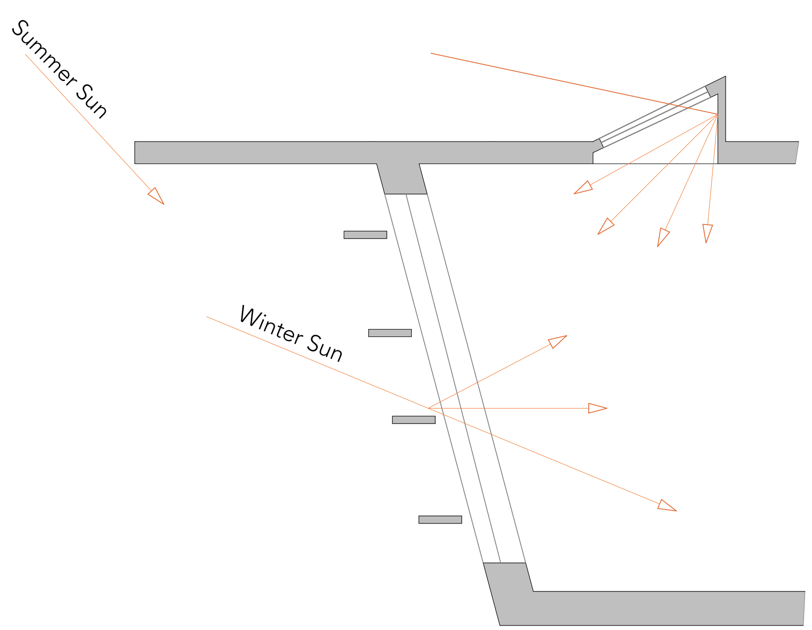


Daylight with tilted facade and louvres. The biggest percent of time 69%

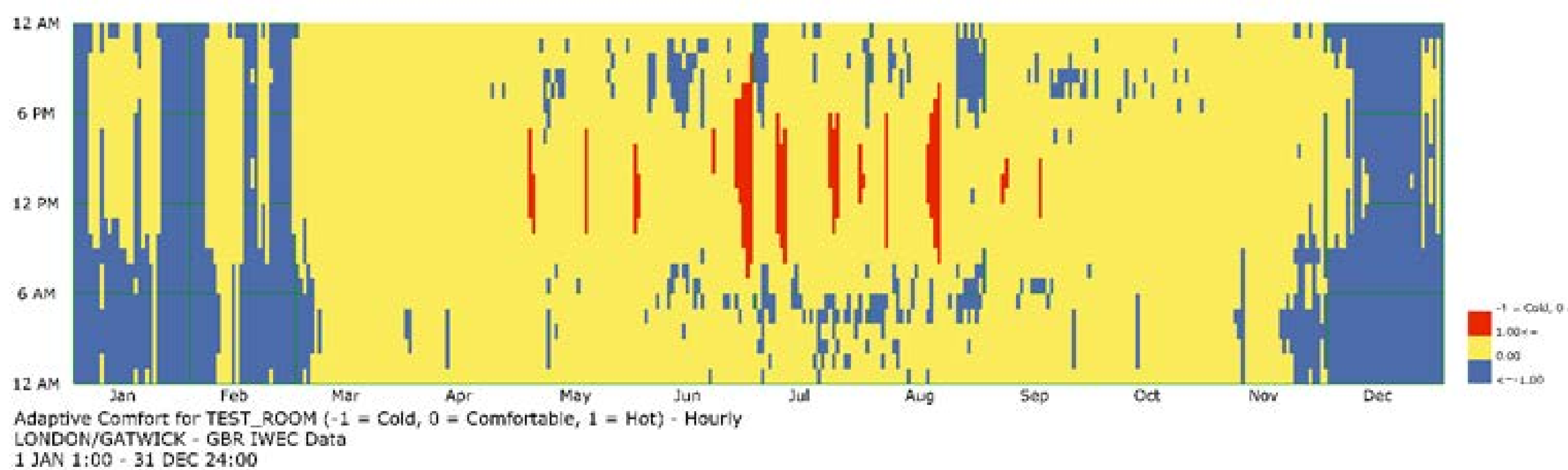




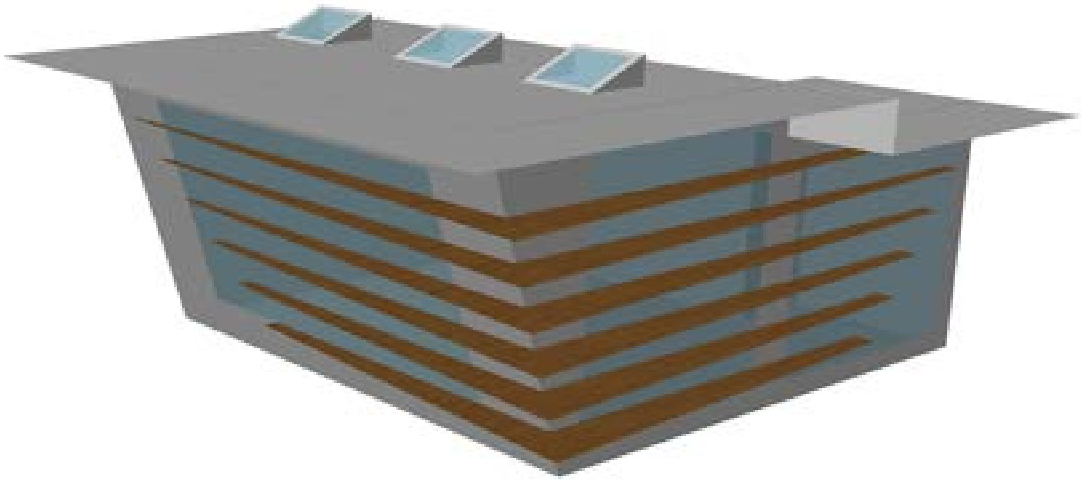
DGP 0.40 with new facade, skylights and louvres. Due to that depth of louvres were adjusted.

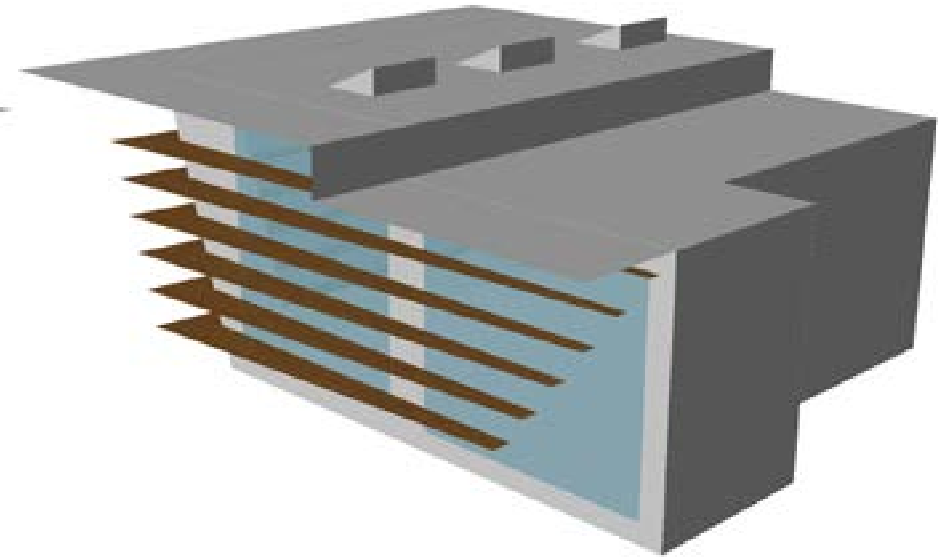


Different angles of Facade, as well as different depth of louvres give different adaptive comfort percent.
It varies in a range 0.59 - 0.75
For the final design was chosen the version which has biggest comfort hour percent and lowest glare.

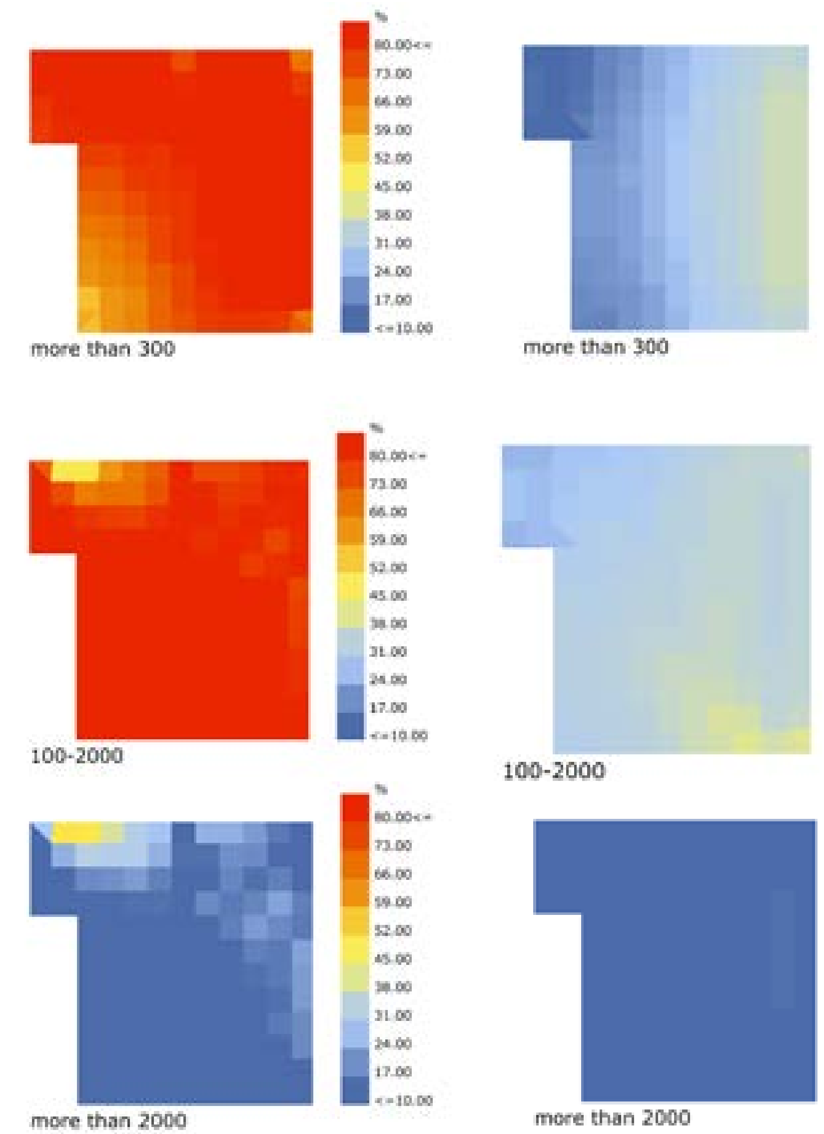


FINAL DESIGN . COMPARISON WITH BASELINE

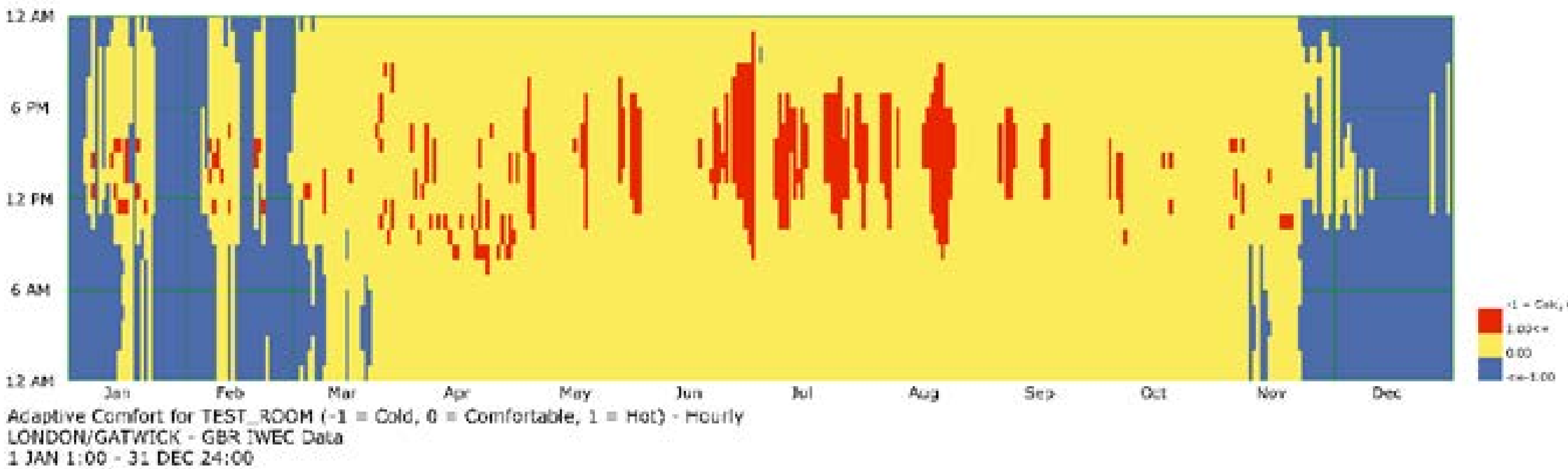




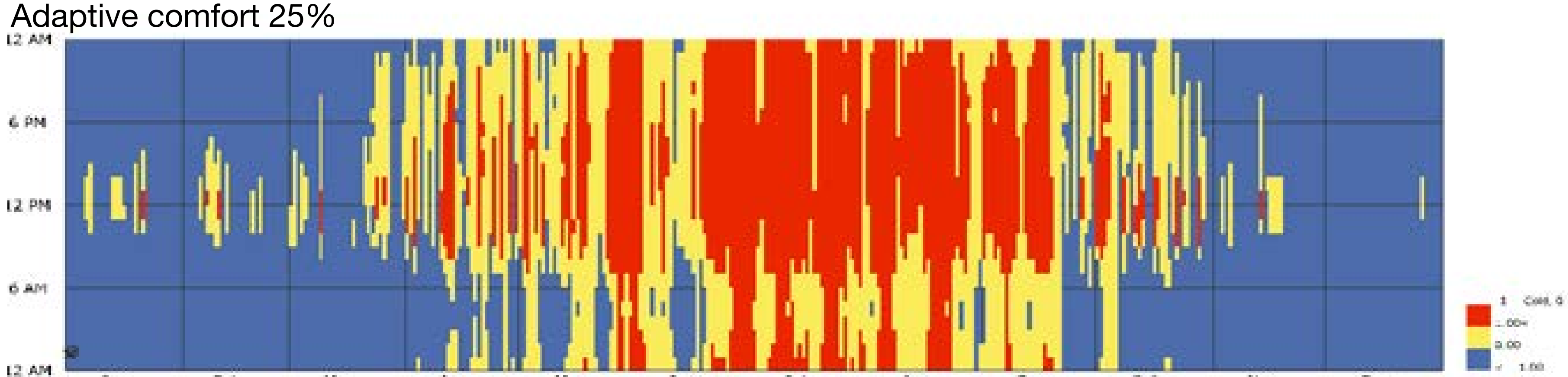
NEW DESIGN BASELINE

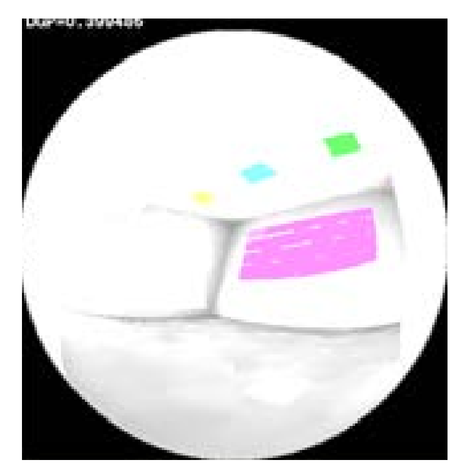


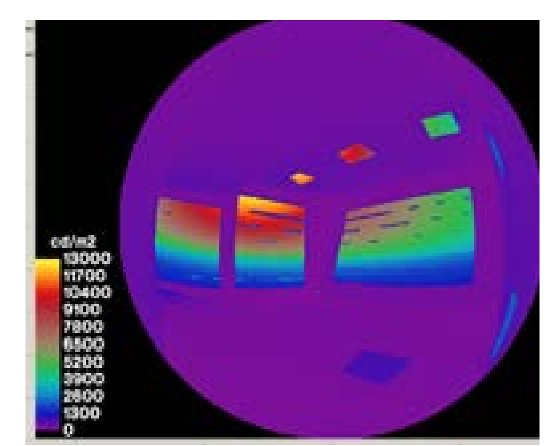
NEW DESIGN.
Adaptive comfort 71%



BASELINE
Adaptive comfort 25%







POSSIBLE IMPROVEMENTS

1. By changing natural ventilation schedule in the summer (according to the global horizontal radiation for example) the overheated hours can be reduced.
2. Setpoints for natural ventilation can be adjusted to have better adaptive comfort.
3. Daylight autonomy graphs would better have same legend for easier comparison.
4. Chimney effect can be used.