Transsolar academy

This is the College of Engineering and Agro-Insdustrial Technology (CEAT). This is where I took my undergraduate studies.

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Staying in the college for 5 ½ years and working for almost 2 years afterwards, there is no doubt, the community has been a large part of my life, and still is.

So, I asked myself:

Is there something I can do to make it better?

And can that something inspire people to do something to make something better?

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The answer that I came up with is the improvement of this lounge.

It is the main social space in the college. It serves as dining, study, and hangout areas for the students.

Is this something I can do that could inspire people to do something to make something better?

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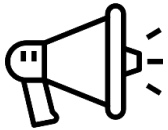
Share knowledge about Klima Engineering



Start a campaign across the whole university

I believe that doing this project would enable knowledge about Klima engineering to be shared.

I also hope that this can start a campaign across the whole university about climate-responsive design.

base case thermal simulation

First, thermal simulation was done using the existing design of the lounge.

SET

SET (° C)	Sensation	Physiology
37.5 - 44	Very hot, great discomfort	increased disruption of evaporative regulation
34.5 - 37.5	Hot, very unacceptable	profuse sweating
30 - 34.5	Warm, uncomfortable, unacceptable	sweating
25.6 - 30	Slightly warm, slightly unacceptable	slight sweat, vasolidation
22.2 - 25.6	comfortable, acceptable	physiological thermal neutrality
17.5 - 22.2	slightly cool, slightly unacceptable	initial vasocontriction
14.5 - 17.5	cool, unacceptable	slow body cooling
10 - 14.5	cold very unacceptable	beginning of shivering

Table from Predicting outdoor thermal comfort in urban environments:
A 3D numerical model for standard effective temperature by Nazarian, Fan, et. al. (2017)

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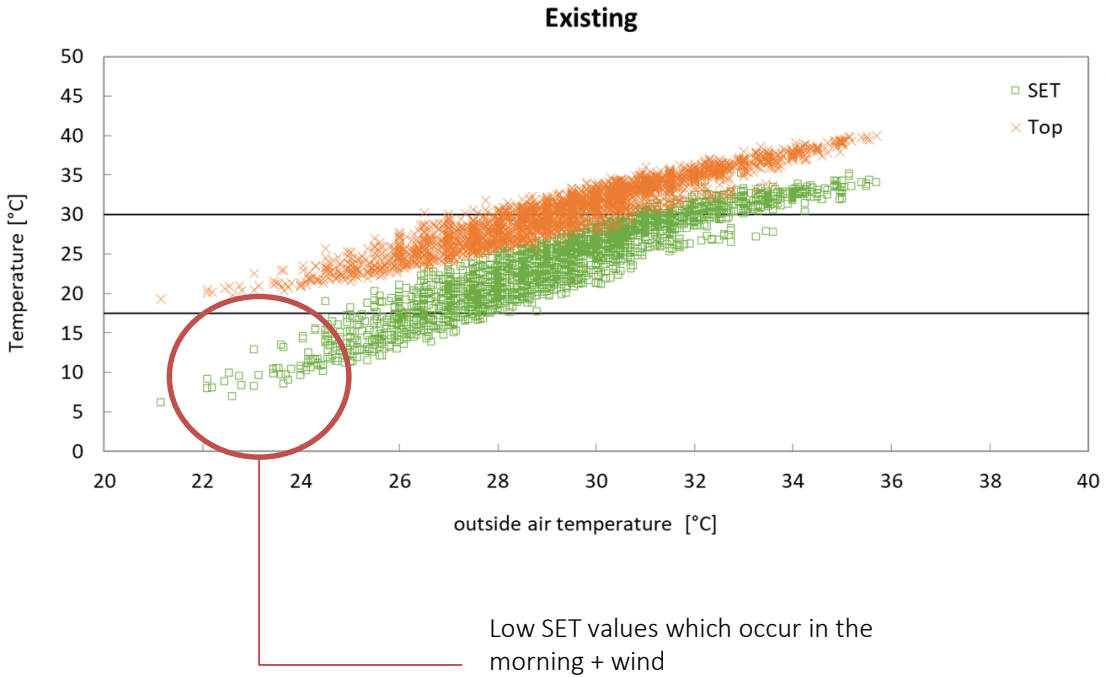
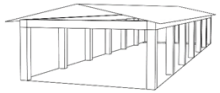
Standard effective temperature (SET) was used as the metric for thermal comfort.

Even though the absolute comfortable range is from 22.2 – 25.6 °C, an extended comfort band from slightly cool to slightly warm (17.5 – 30 °C) was considered because in naturally ventilated buildings, occupants can accept a wider range of temperatures.

Base Case | Open Walls

07:00 to 18:00





Result shows the SET and operative temperature (Top) with the current design.

It can be observed that not all values are within the comfort band.

It can also be noted that there are low SET values, which occur in the morning, and can be explained due to high wind at those times.

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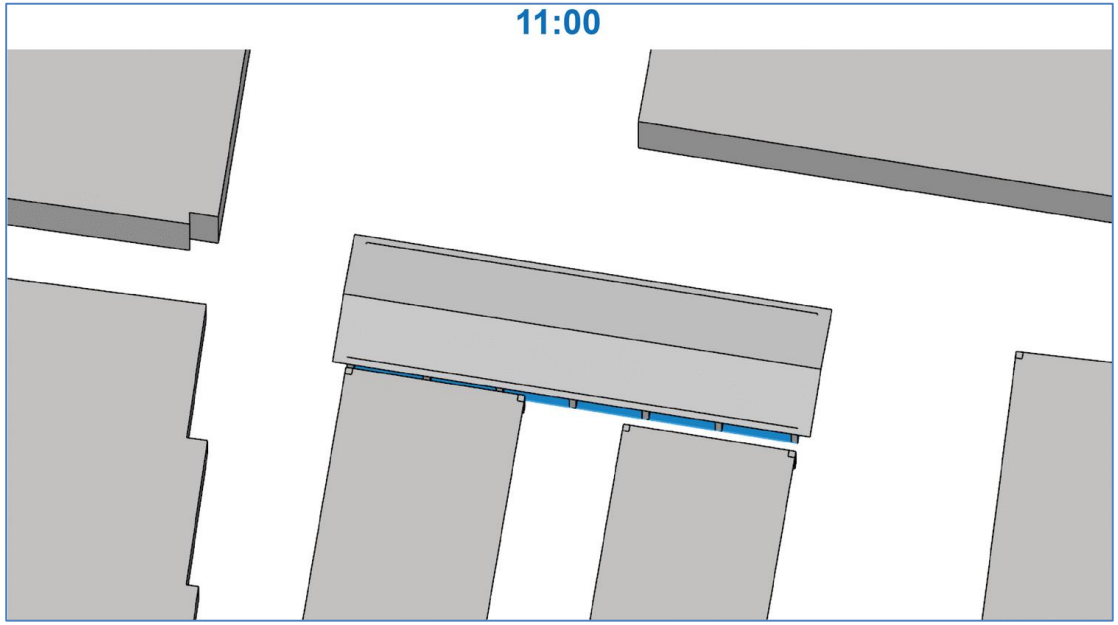
So, I asked myself, what is causing the space to heat up?

what is causing the space to heat up?

View from the sun



GIF

To answer that question, view from the sun study was done.

Here we can see that the sun ‘sees’ the floor almost the whole day.

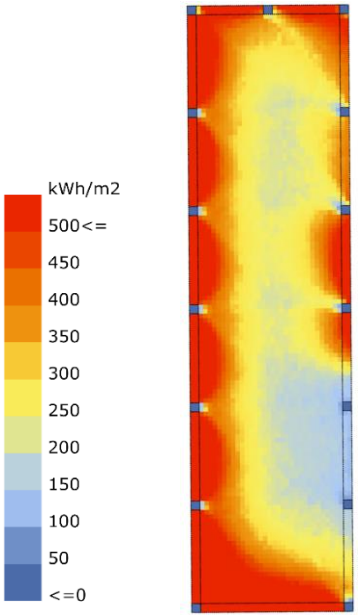
to understand the effect of both high- and low-angle sun

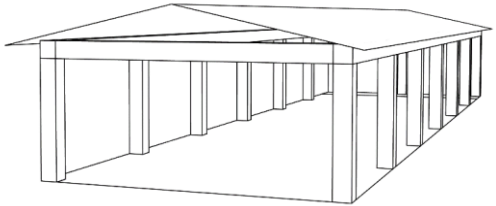
Hence, to understand the effect of the both the high- and low-angle sun, solar radiation study was done.

Several design solutions of blocking the direct sun from striking the floor were explored.

Base Case | No Walls

Year - 0 to 24 hr





Total Annual Radiation

107.6 kWh

Radiation from both high- and low- angle sun

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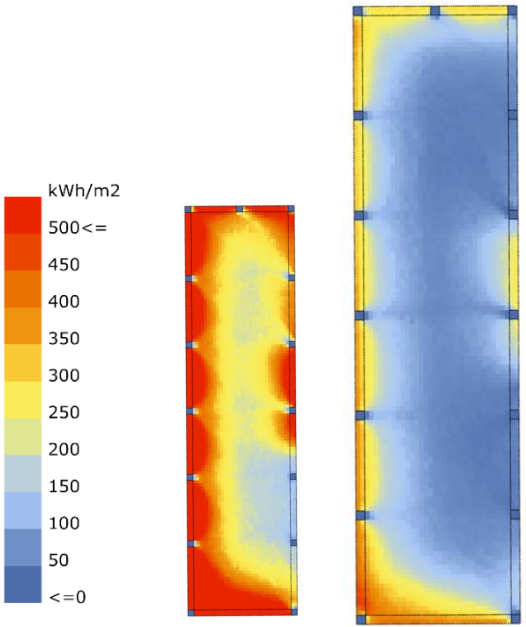
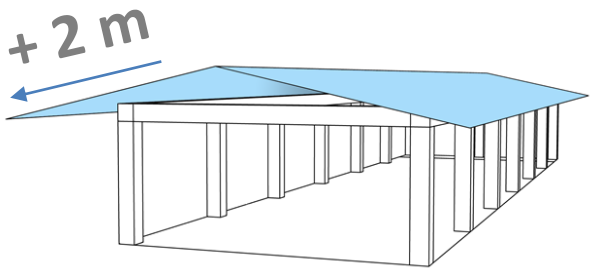
With the existing design, high levels of solar radiation in the perimeter is being received.

Total annual radiation is 107.6 kWh.

Extended Roof

Year - 0 to 24 hr





Reduction

65.0 %

Extended roof overhang reduces radiation from both high and low-angle sun.

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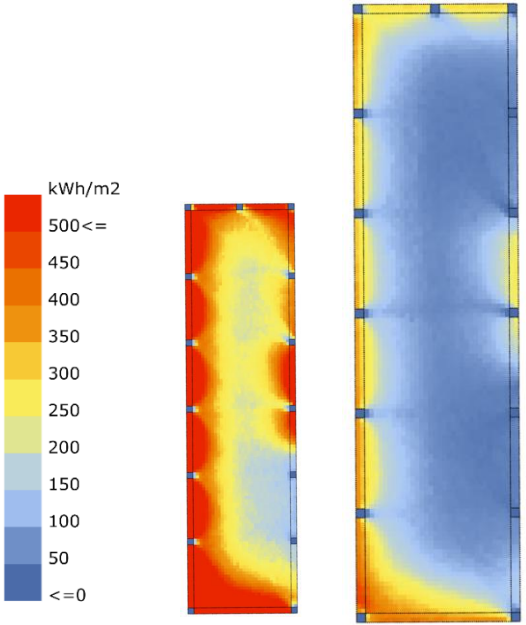
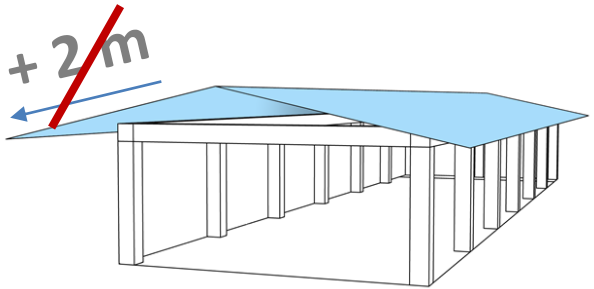
Extending the roof by 2 m decreased the radiation from both the high- and low-angle sun.

Total annual radiation was reduced to 65%.

Extended Roof

Year - 0 to 24 hr





Reduction

65.0 %

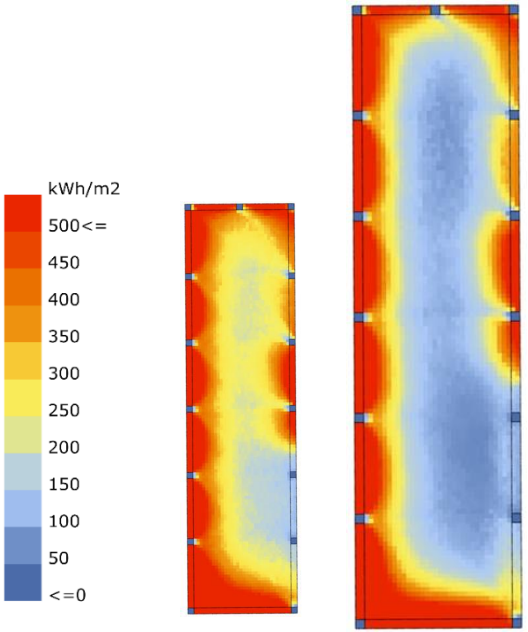
Extended roof overhang reduces radiation from both high and low-angle sun.

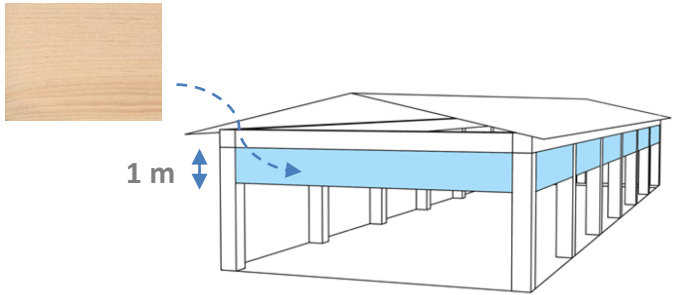
2 m roof extension is impractical

But, it is impractical because large roof overhangs are susceptible to damage by strong winds.

Screen

Year - 0 to 24 hr





Reduction

24.8 %

Screen reduces radiation from the low-angle sun.

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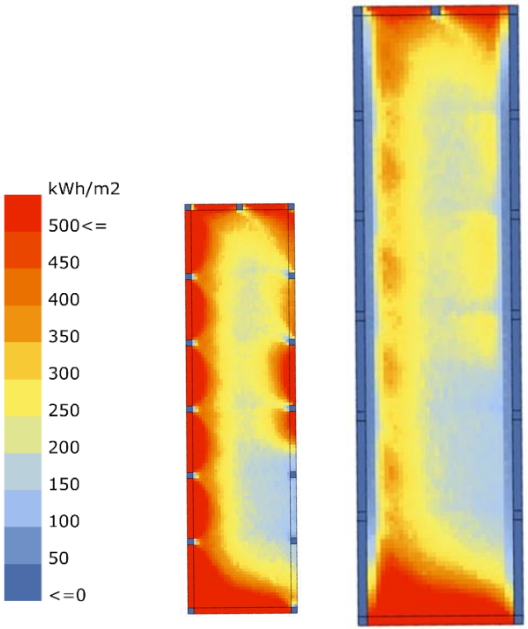
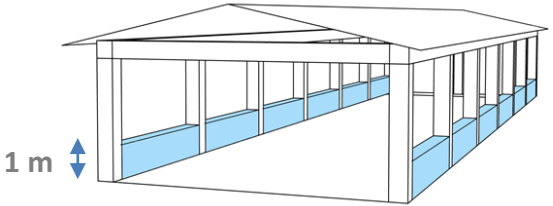
Putting a 1 m opaque screen at the upper half of the wall reduces total annual radiation by 24.8%.

Screen reduces radiation at the center of the space.

Parapet

Year - 0 to 24 hr





Reduction

38.1 %

Parapet reduces radiation from high-angle sun.

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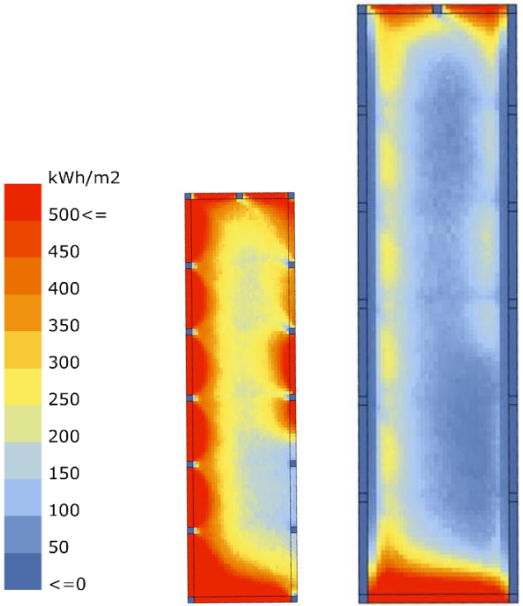
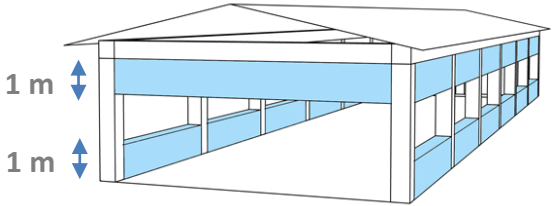
Putting 1 m parapets decreases radiation in the perimeter.

Total annual radiation was reduced to 38%.

Curtain + Parapet

Year - 0 to 24 hr





Reduction

63.2 %

Radiation from both high and low-angle sun is reduced.

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What if we combine the screen and parapet?

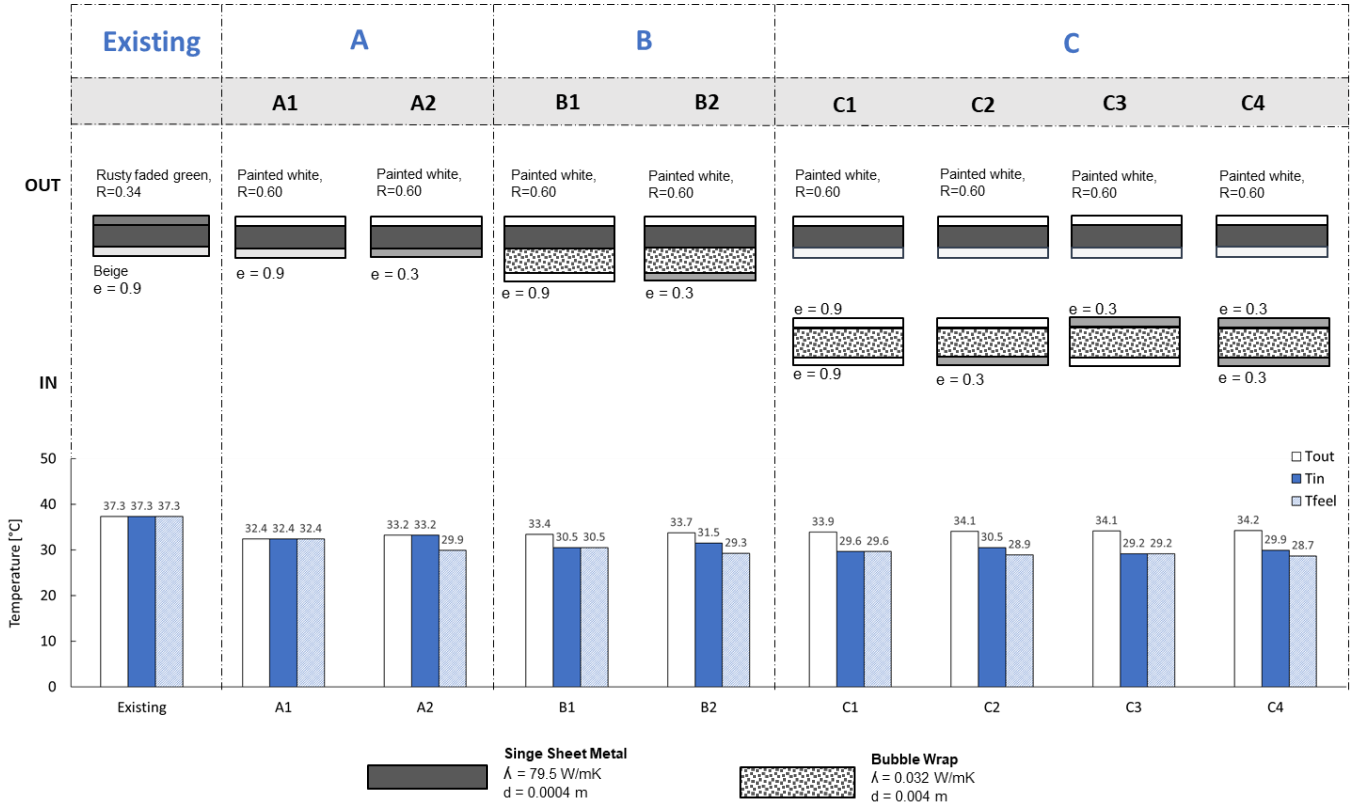
Total annual radiation is reduced to 63%.

~~façade~~

roof ?

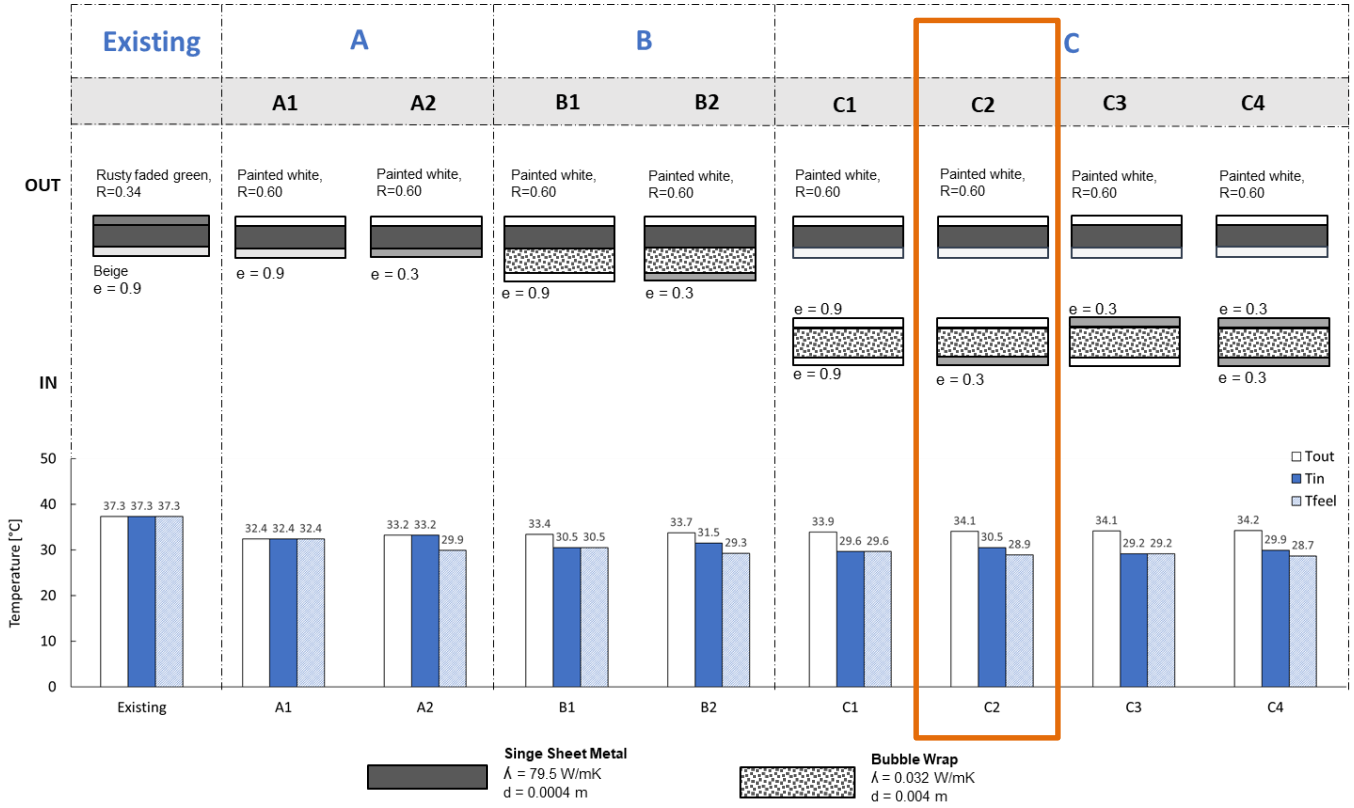
Now, we have solutions for the façade, how about the roof?

Roof Variants – EES calculation



Eight roof build-ups were tested. Using EES, T_{out}, T_{in}, and T_{feel} is calculated.

Roof Variants – EES calculation



Among all the build-ups, variant C2 is considered the best.

Outside roof is painted white, insulation is separated by an airgap, and has low-e coating on the surface facing the inside space.

~~façade~~

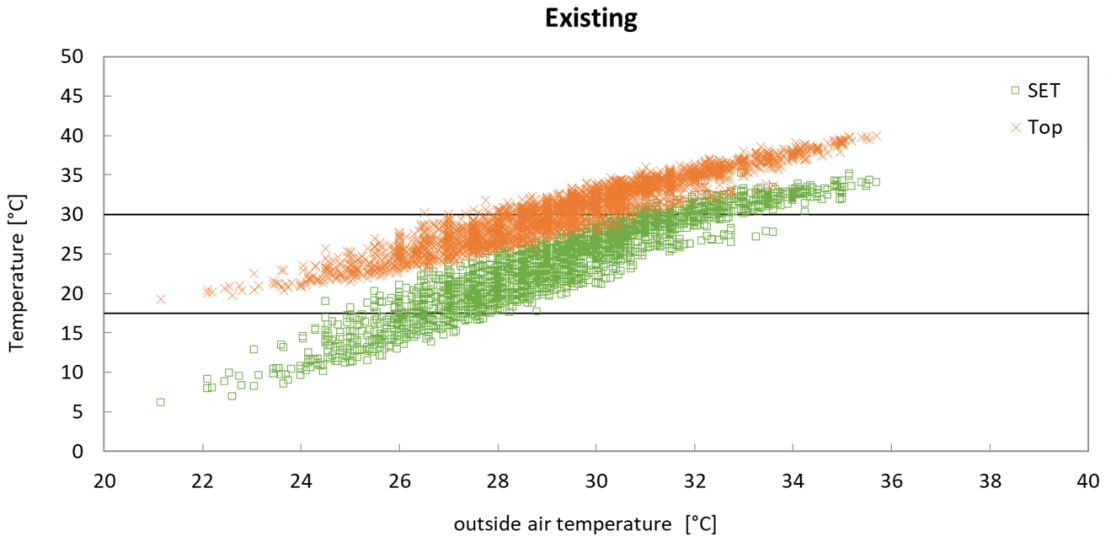
~~roof~~

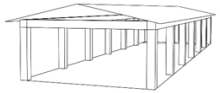
Now, we have solutions for both the façade and roof.

Next, thermal simulation were performed using the different design solutions for façade and roof.

Base Case | No Walls

07:00 to 18:00

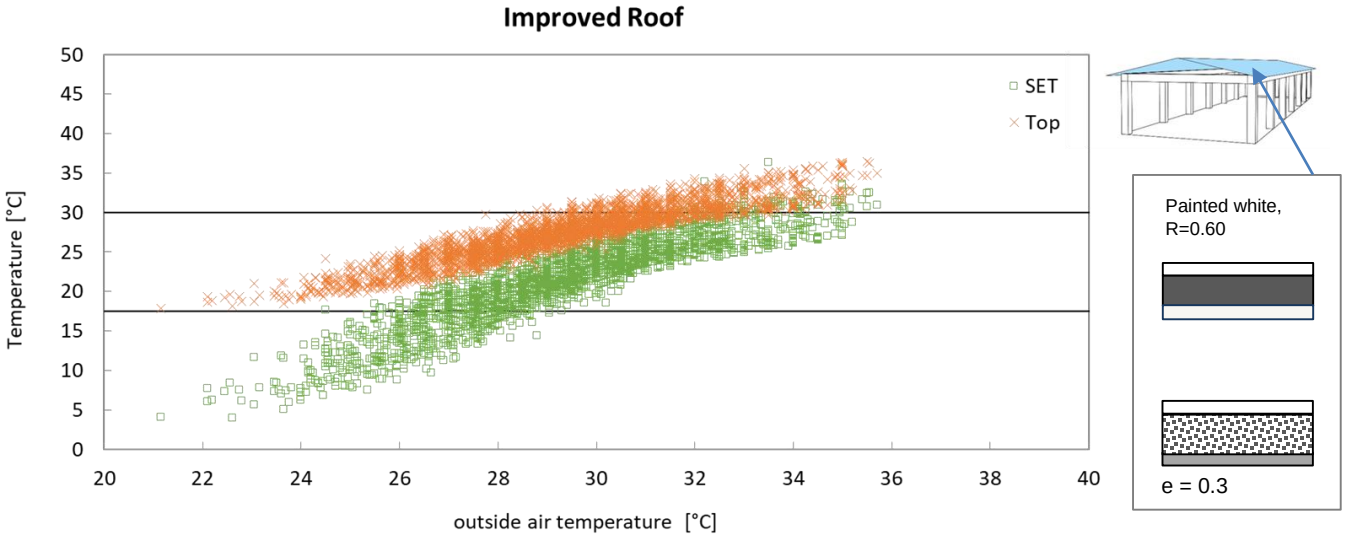




Again, showing the temperatures in with the base case.

Improved Roof

07:00 to 18:00

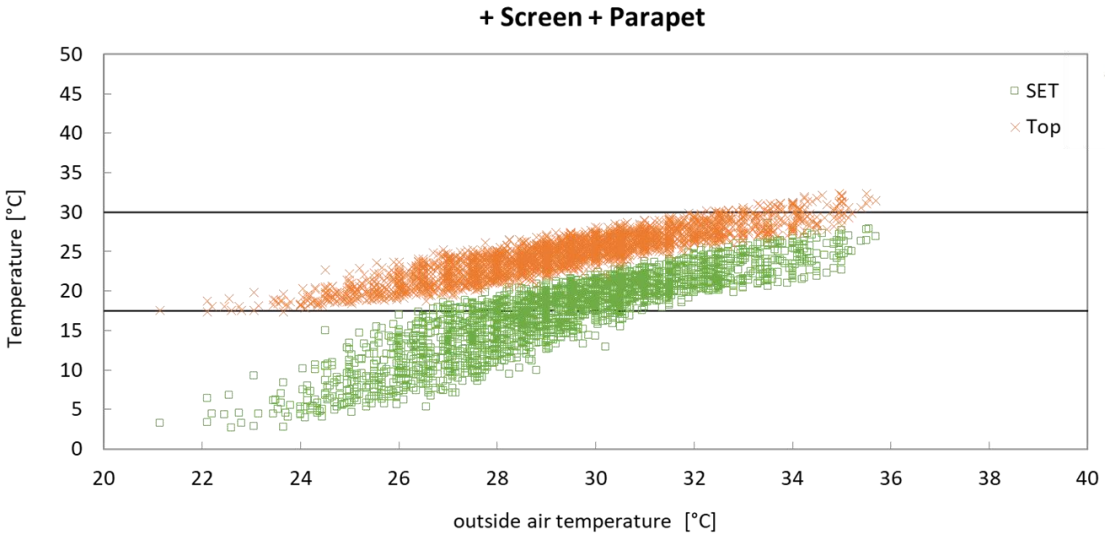


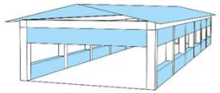
Now, we improve the roof.

We can see that temperatures decreased.

+ Screen + Parapet

07:00 to 18:00





Using screen and parapet, temperatures where further reduced.

monsoon season

In the current design, water enters the inside space due to the lack of walls, especially when rain is accompanied by strong winds.

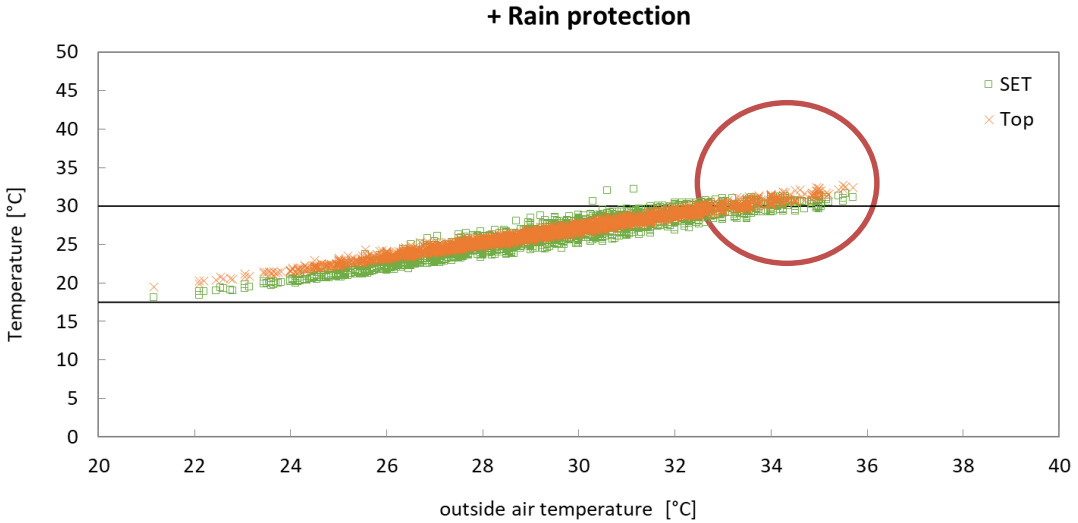
Therefore, rain protection was included among the design solutions.

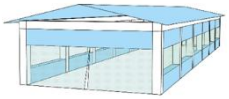
This protection was assumed to be transparent to maintain views to the outside and to allow daylight inside the space.

This should be operable, to be only used when it is raining.

+ Rain protection

07:00 to 18:00





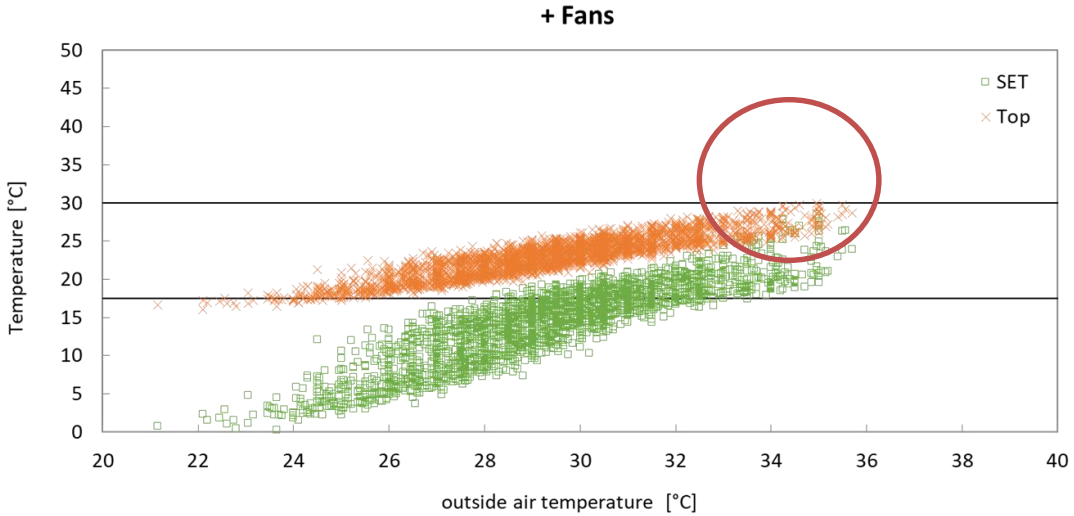
For simplicity, in setting up the thermal model, the rain protection was assumed to be in use all the time

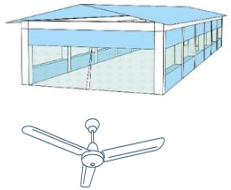
Graph shows that the low SET values without the protection is now within the **extended** comfort band.

However, there are still hours when inside space is perceived unacceptably warm.

+ Fans

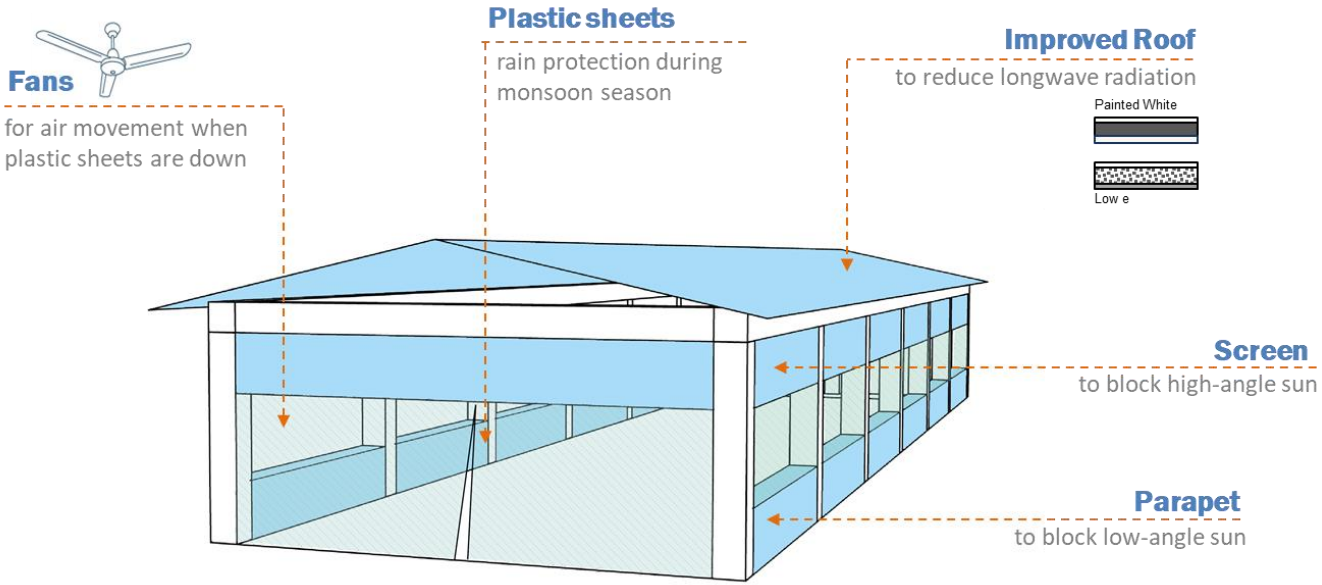
07:00 to 18:00





For these hours, fans can be used to supply some air movement which increases comfort.

Design recommendations



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In summary, these are the design solutions that can be implemented to improve comfort in the lounge.

Cost

	PhP	Eur
Paint	22,500	375
Insulation	60,000	1,000
Screen	24,000	400
Parapet	24,000	400
Plastic sheets	24,000	400
Labor	20,000	350
TOTAL	**162,000**	**2,925**

Implementing these solutions will cost around 3,000 Eur.

Cost

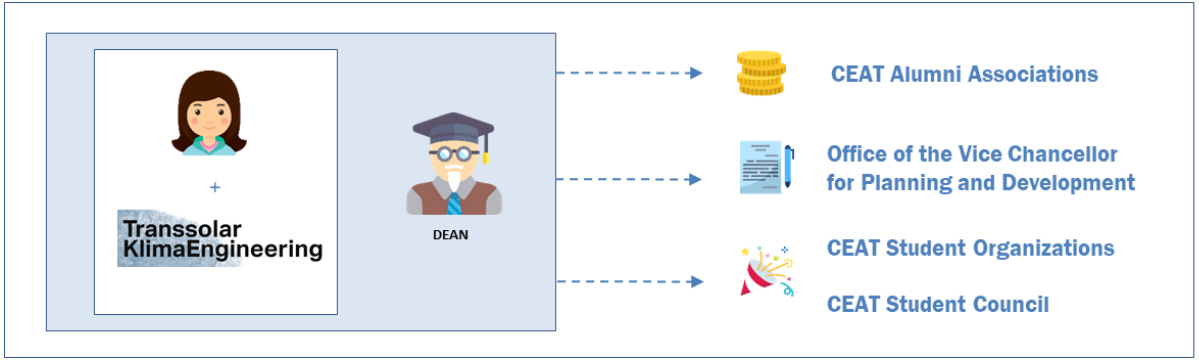
	PhP	Eur
Paint	22,500	375
Insulation	90,000	1,500
Screen	24,000	400
Parapet	24,000	400
Plastic sheets	24,000	400
Labor	20,000	350
TOTAL	**162,000**	**2,925**

Sponsors

0€

But, with sponsors, this cost can go down to 0.

How to make it happen?



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Now, the next step is to communicate with the college administration, alumni associations for funding, and get the students involved.

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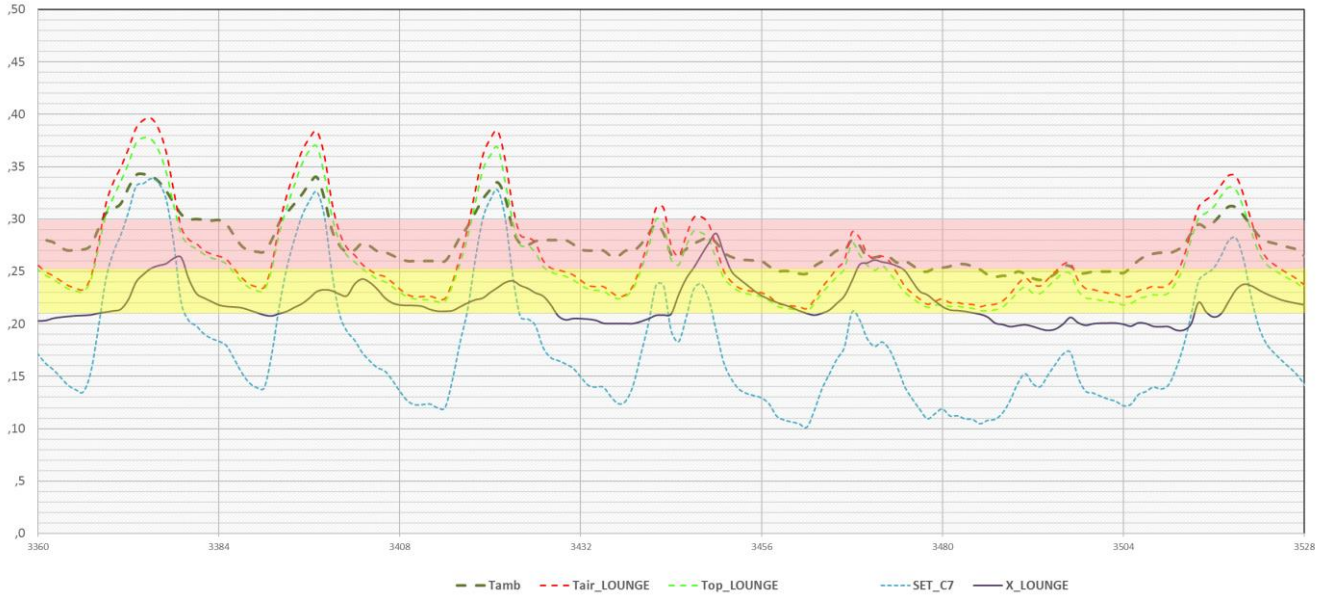
Thank you

Base Case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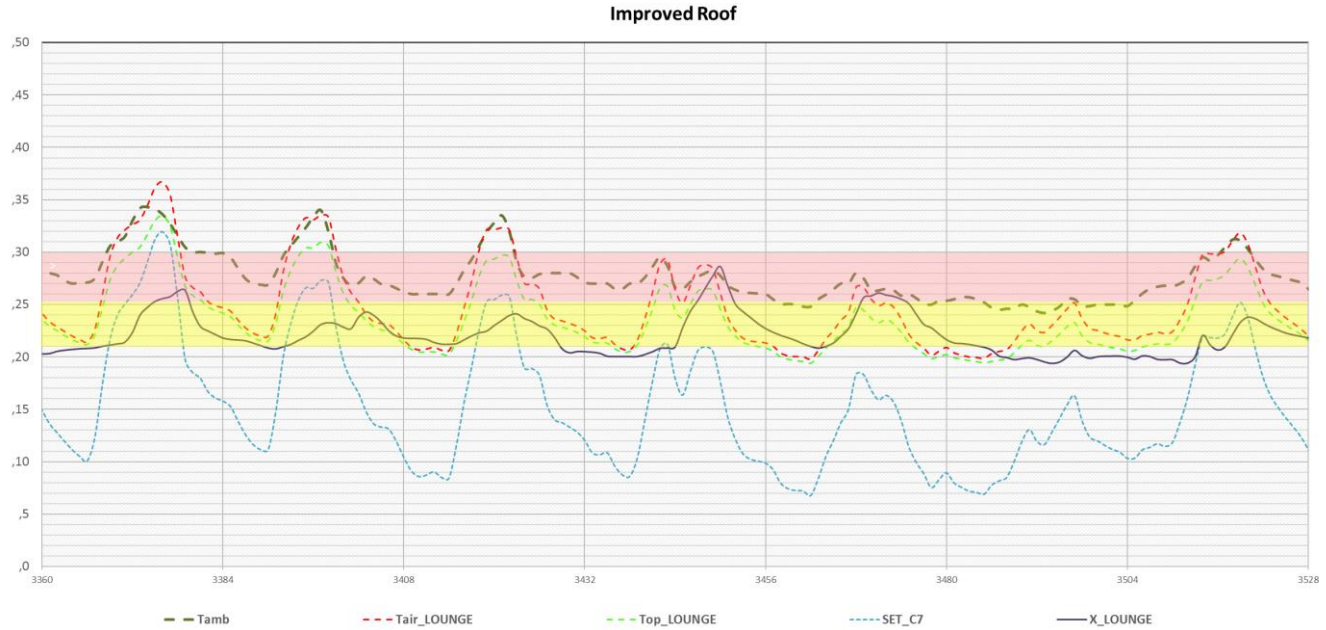
Improved Roof
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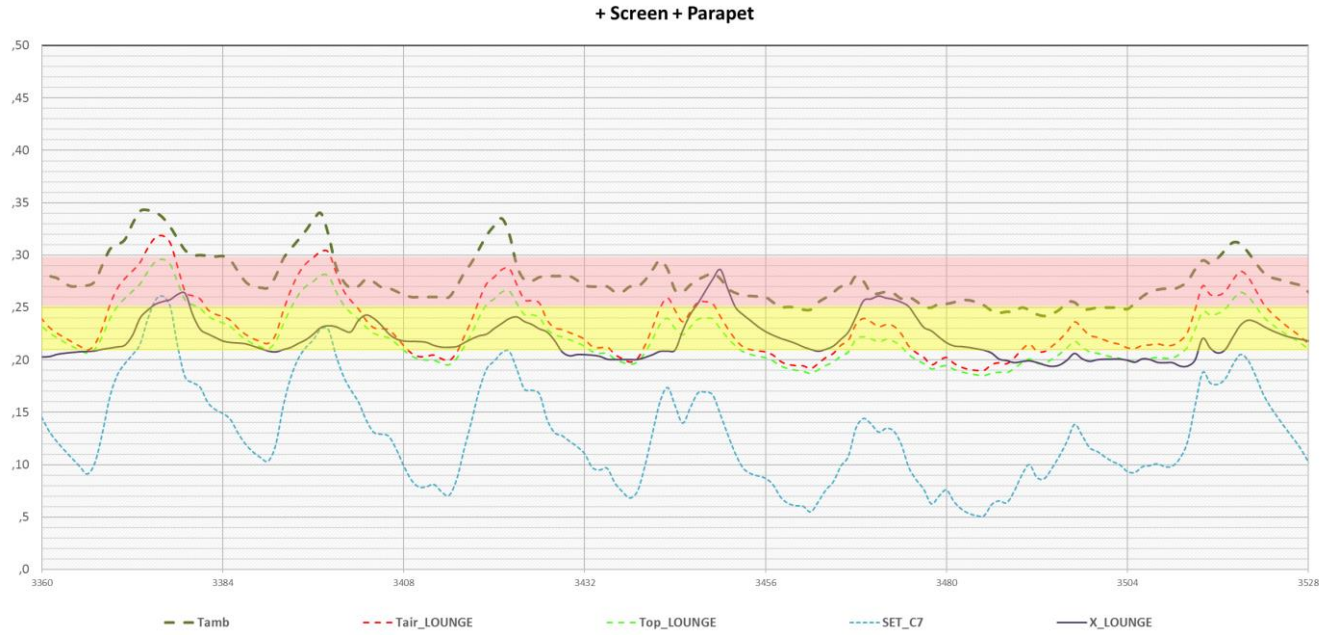
+ Screen + Parapet
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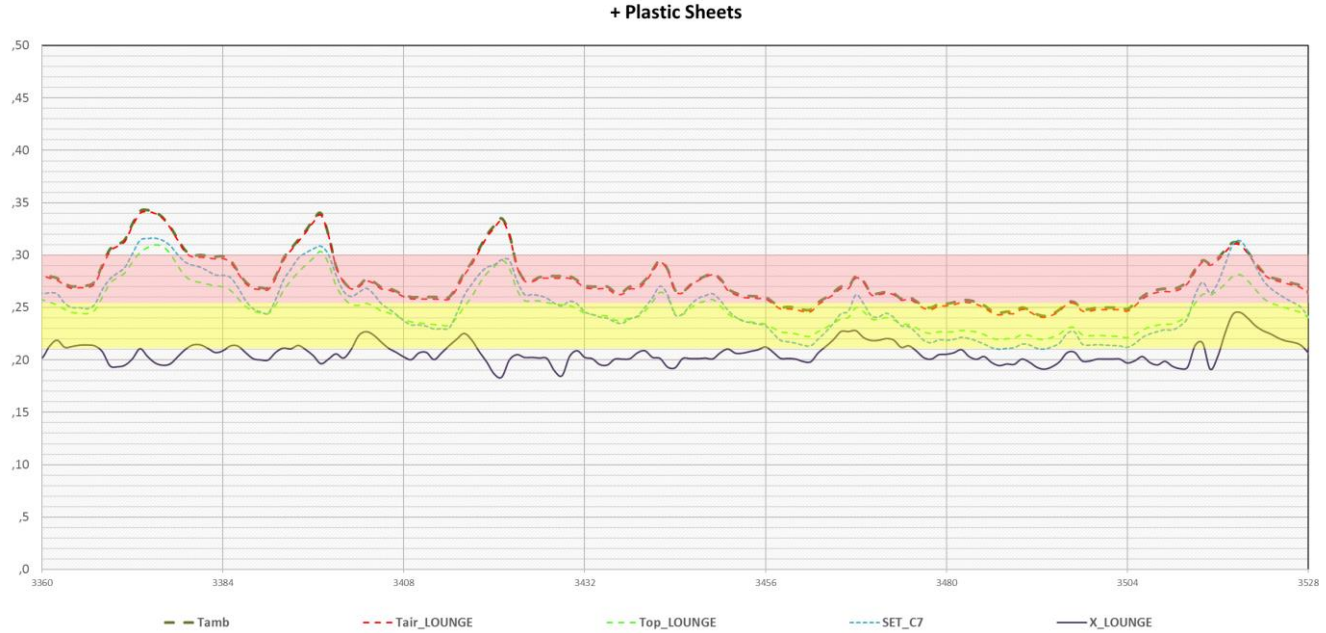
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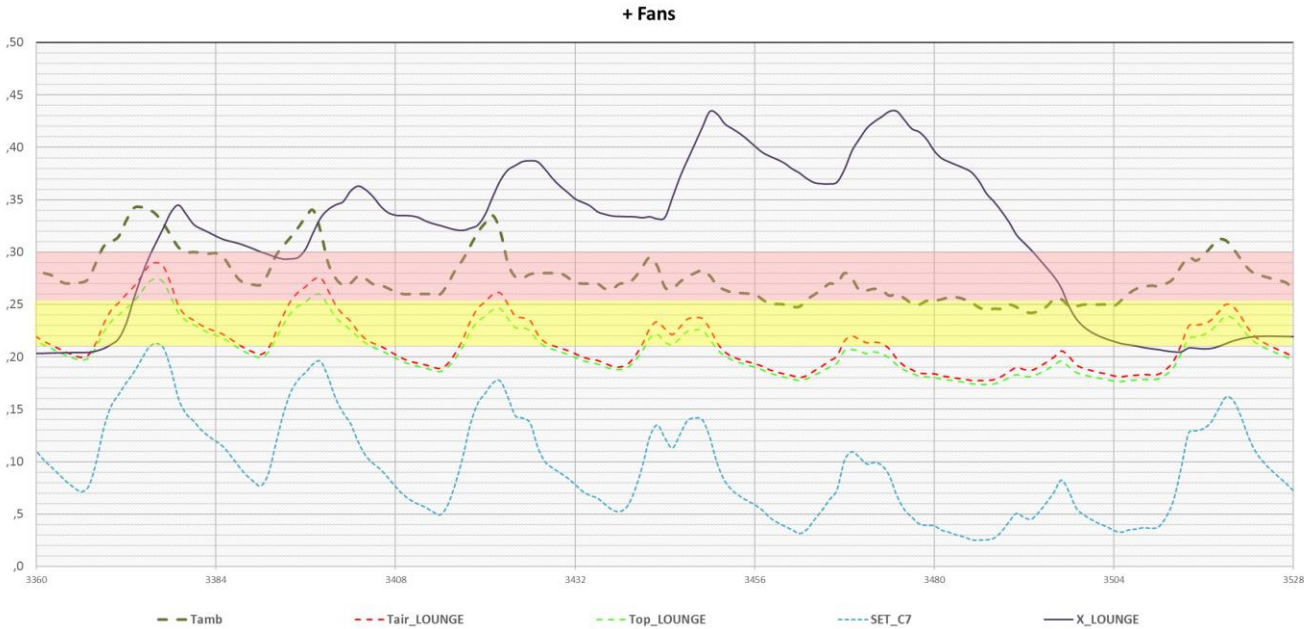
+ Fans
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