SharkFins

Pearl, Svenja, Mateo

4.464 Environmental Technologies in Buildings

Site | Initial Massing | Benchmarking

Site

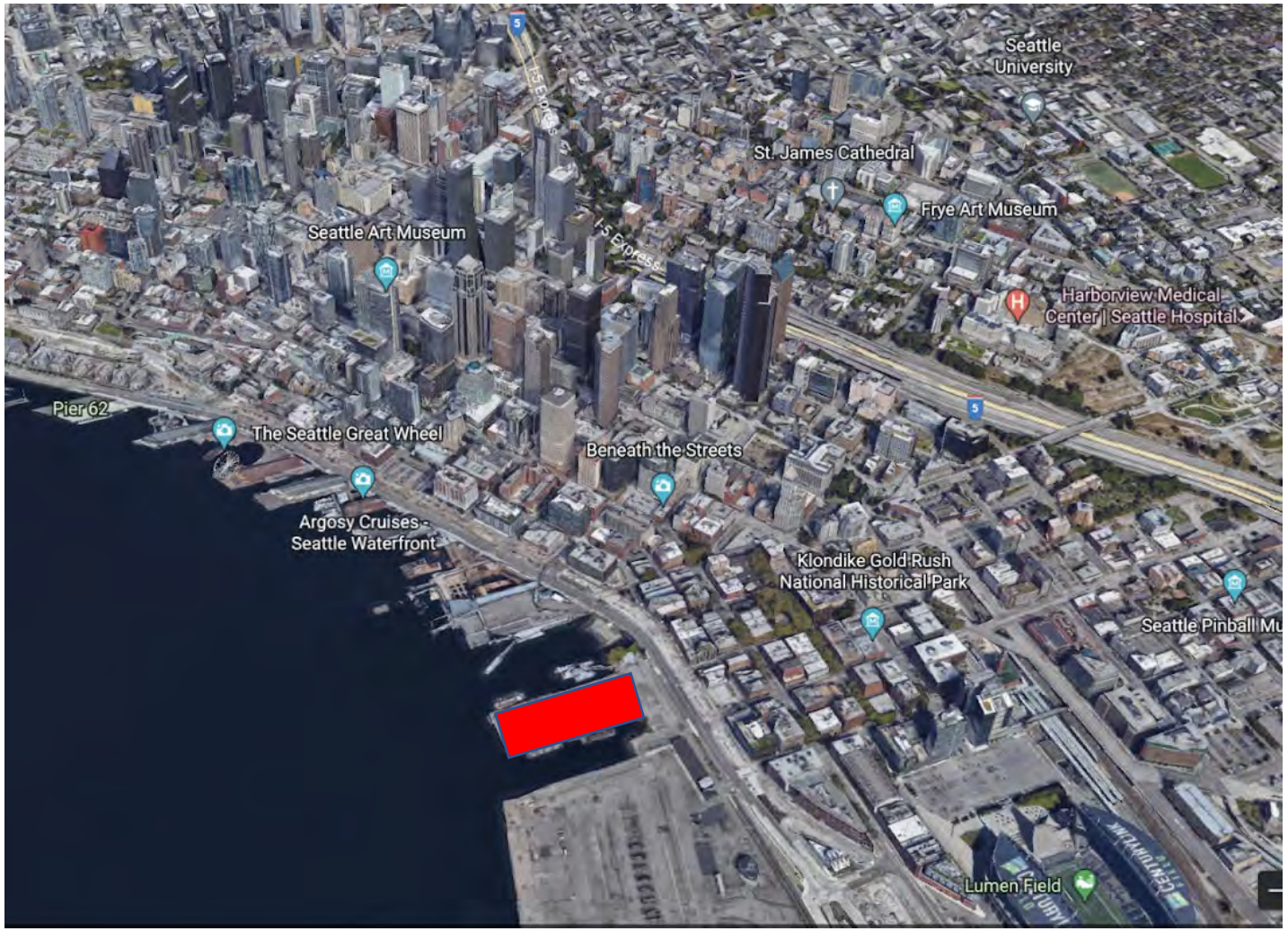
Location: Seattle, Washington

ASHRAE Climate Zone 4C

Architects: Mateo

Engineer: Svenja

Project Manager: Pearl



Guiding Principles

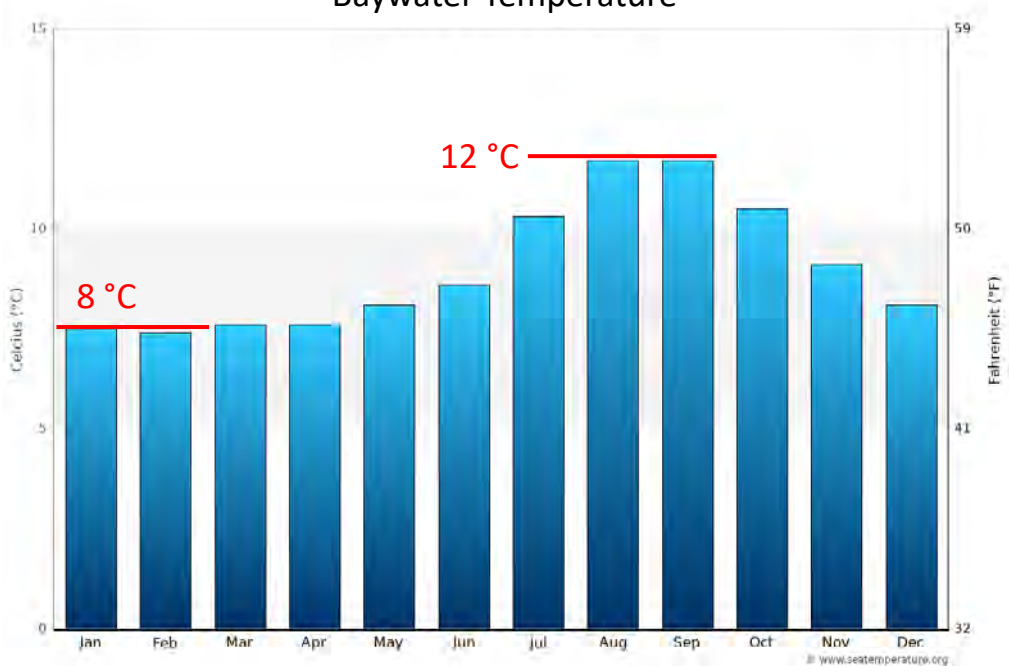
- Minimize unoccupied hours
- Maximize occupant comfort
- Achieve low EUI by responding to the climate

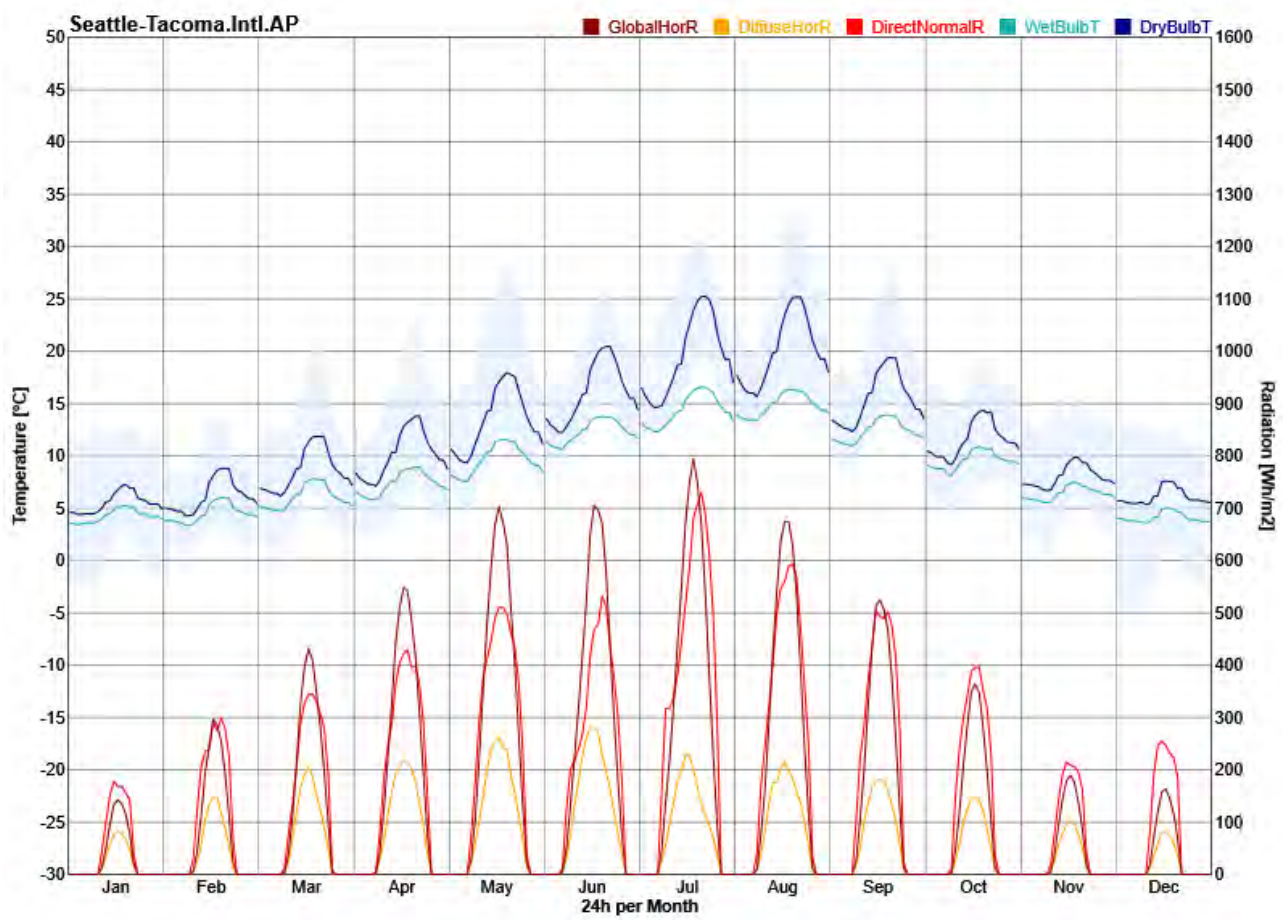
Location

Surroundings-Urban Setting

Climate Context

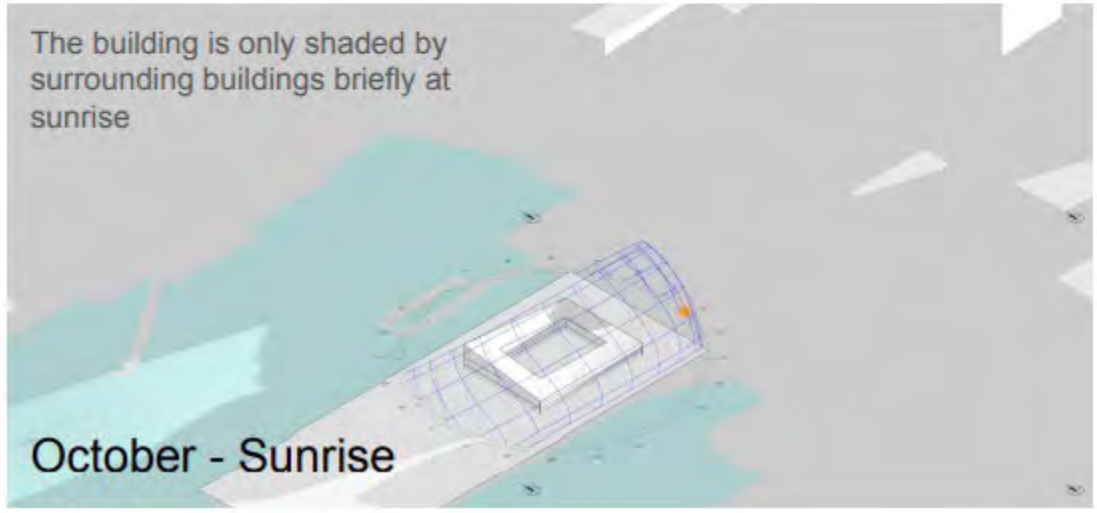
Baywater Temperature



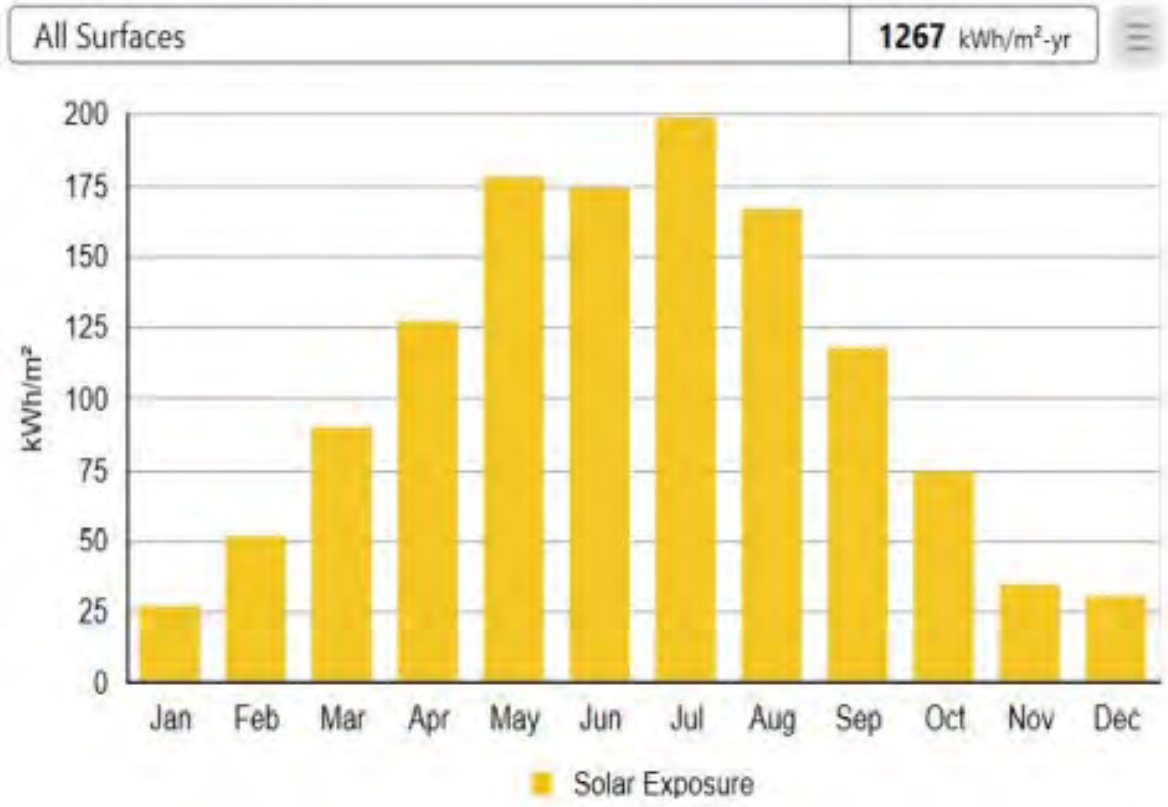


Climate Zone: 4C

Initial Massing



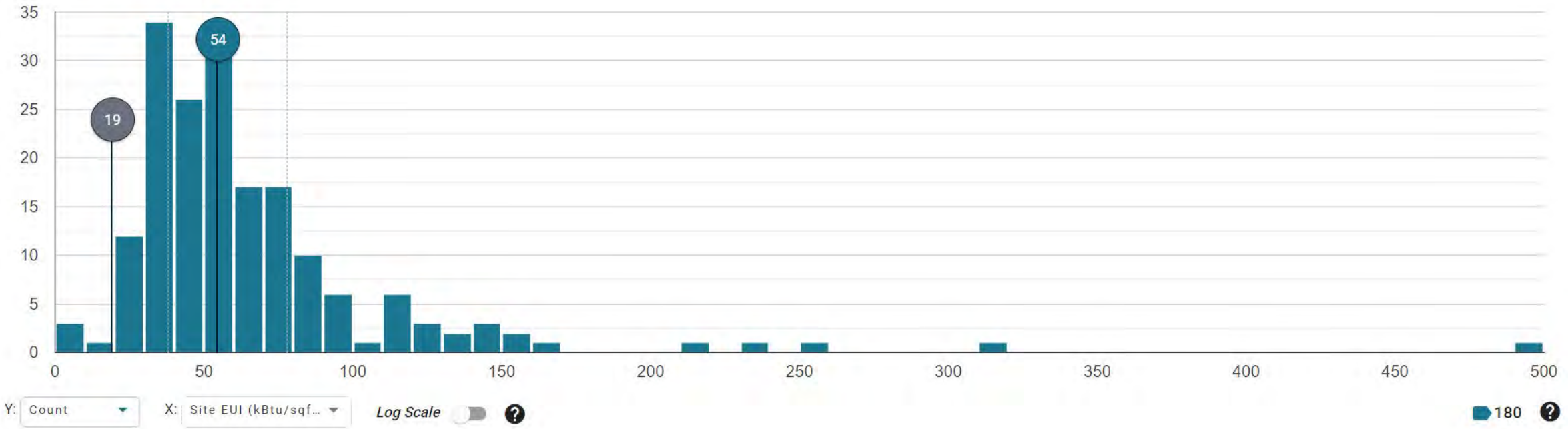
EUI Benchmarking



- Roof Area: 1630 m2
- Footprint: 5800 m2
- 1267kWh/m2-y total solar radiation on PV surface
- Assumed PV efficiency: 18%
- Assumed inverter efficiency: 96%
- Max EUI that PV system can support: 61.5 kWh/m2 (19.5 BTU/ft2)

Target EUI: below 61 kWh/m2 (19.5 BTU/ft2)

EUI Benchmarking



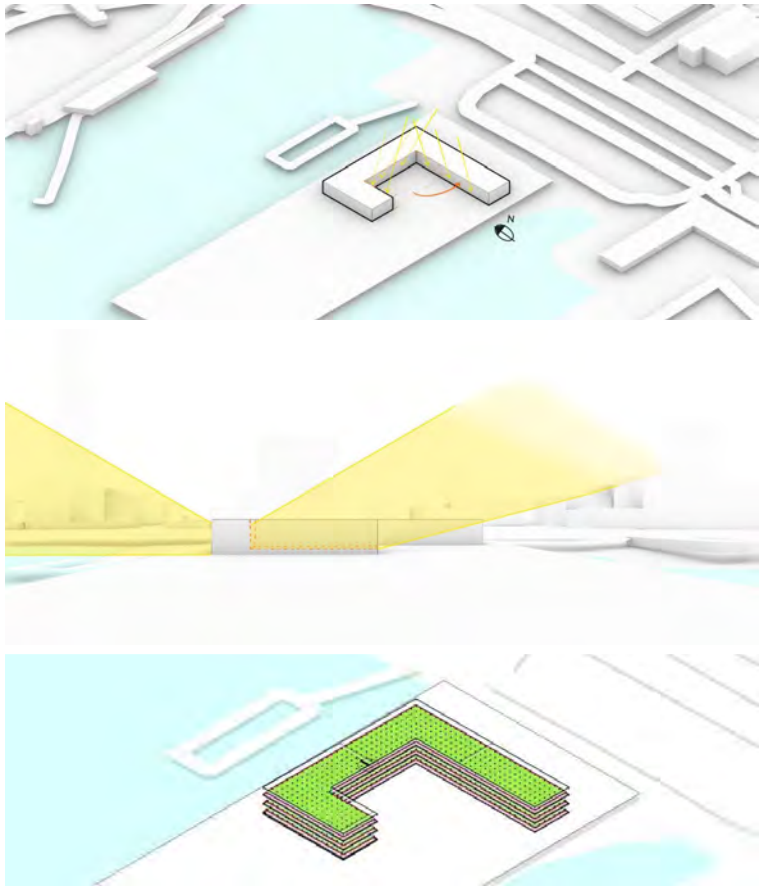
Office buildings in climate zone **4C** (built between 2000-2021)

Building has to be in the **98th percentile** to be net zero

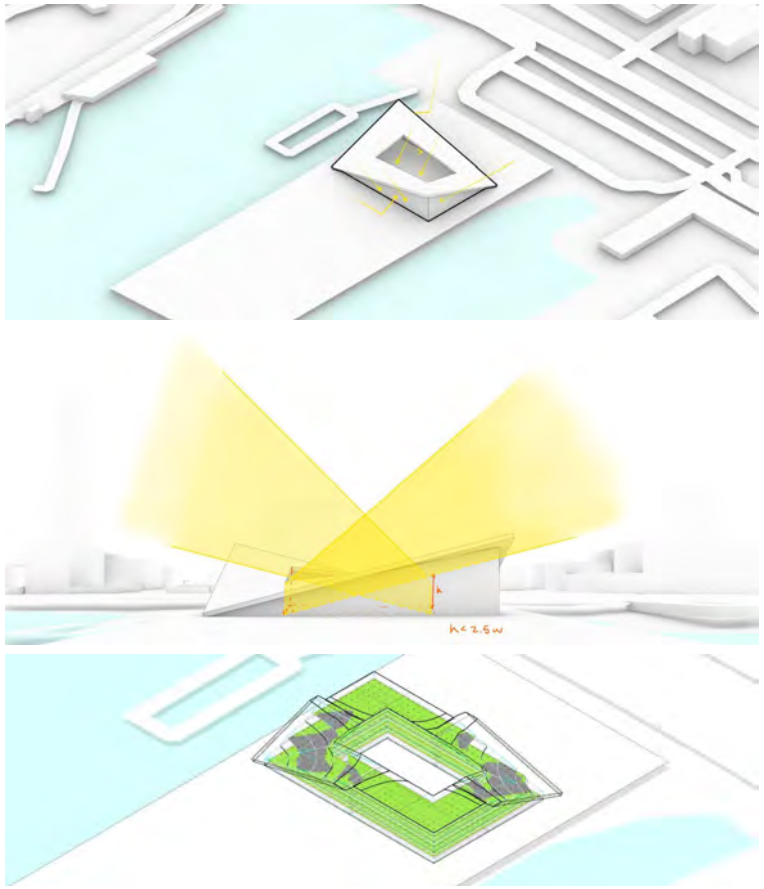
Target EUI: below 61 kWh/m2 (19.5 BTU/ft2)

Daylight | Electric Light

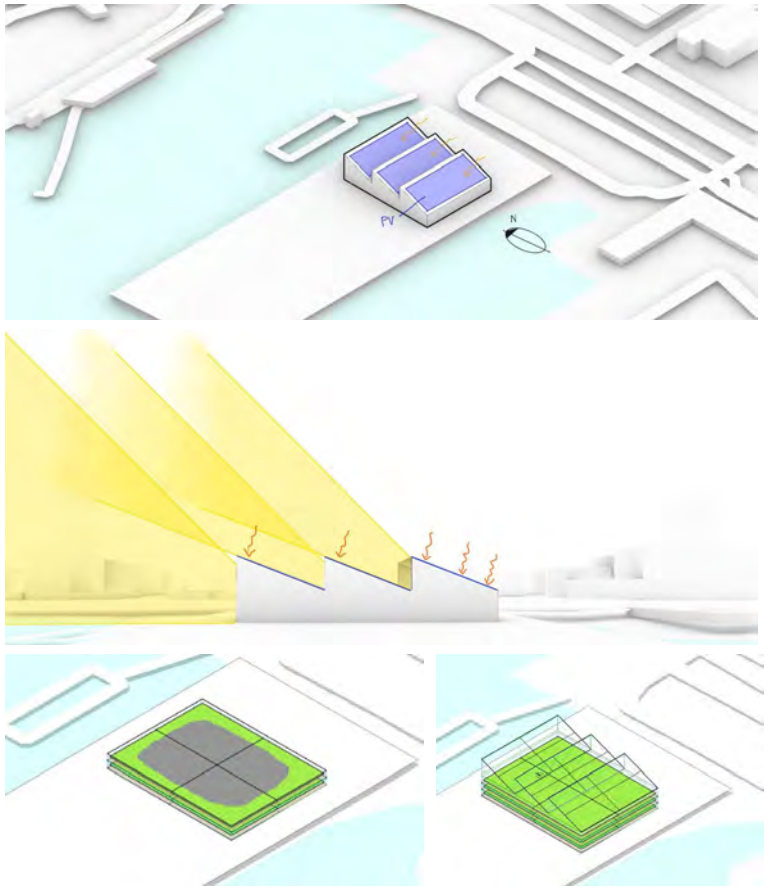
Daylight Concept Overview



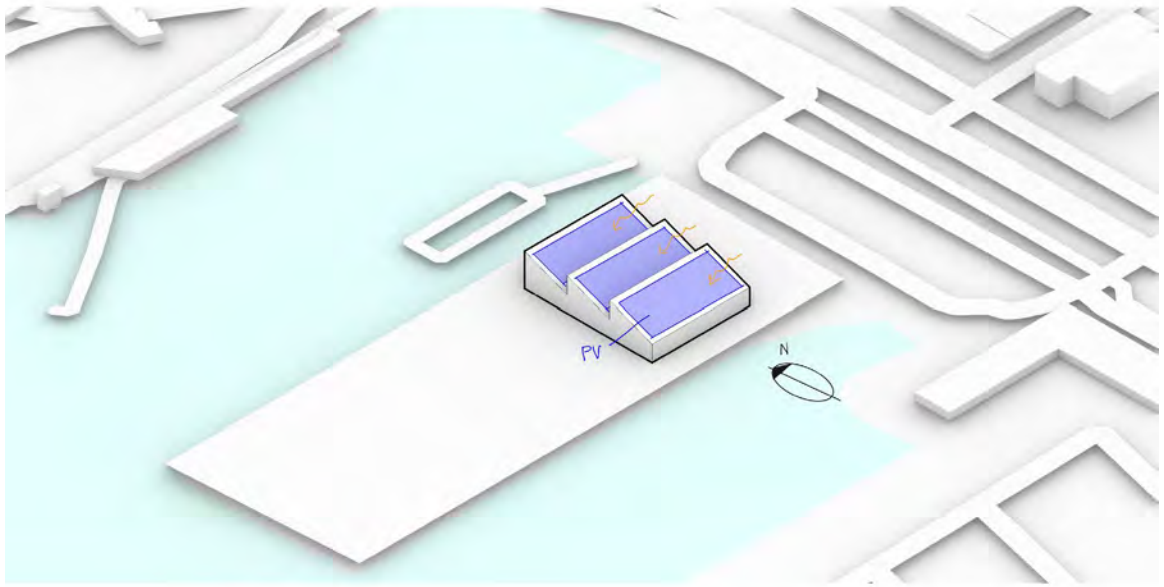
sDA = 100%
ASE = 39.2%

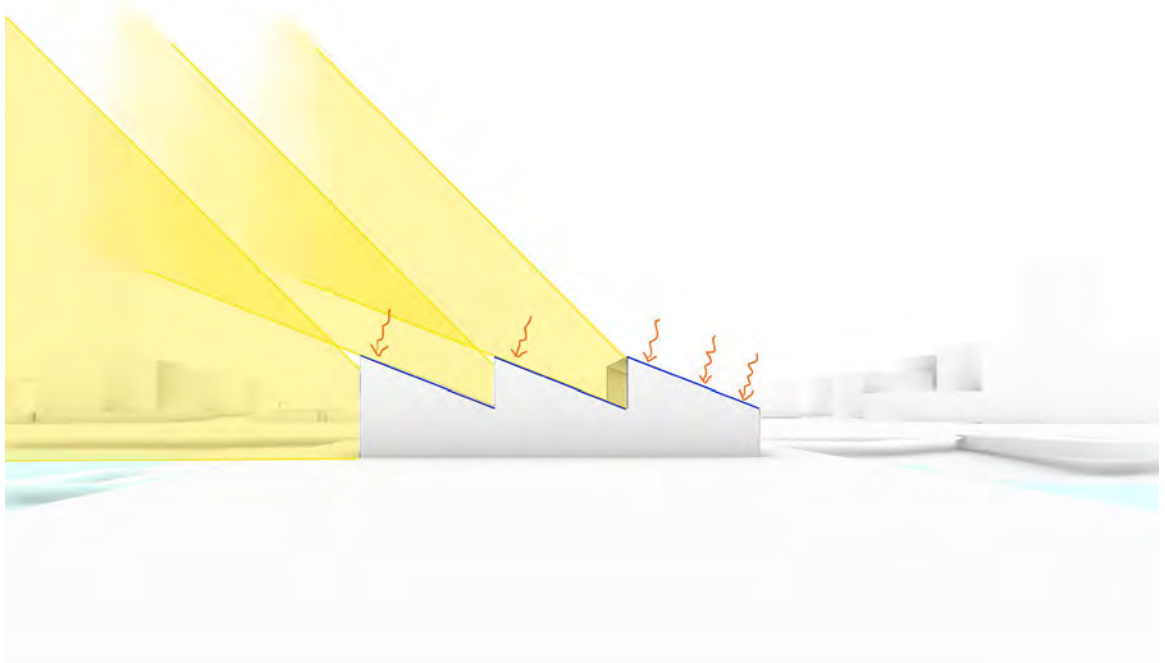


sDA = 86.8%
ASE = 17.3%

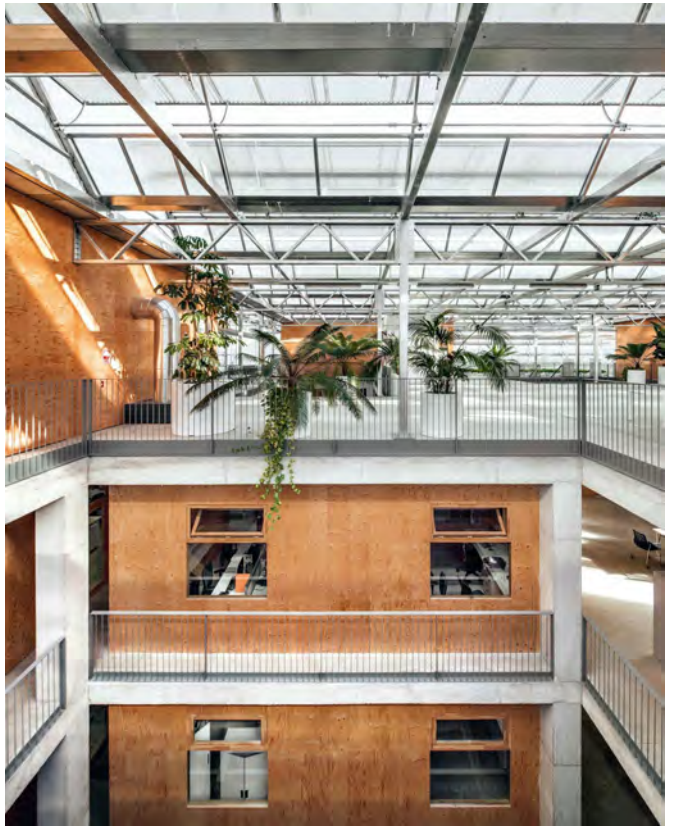


sDA = 59.8%
ASE = 13%


PV
N

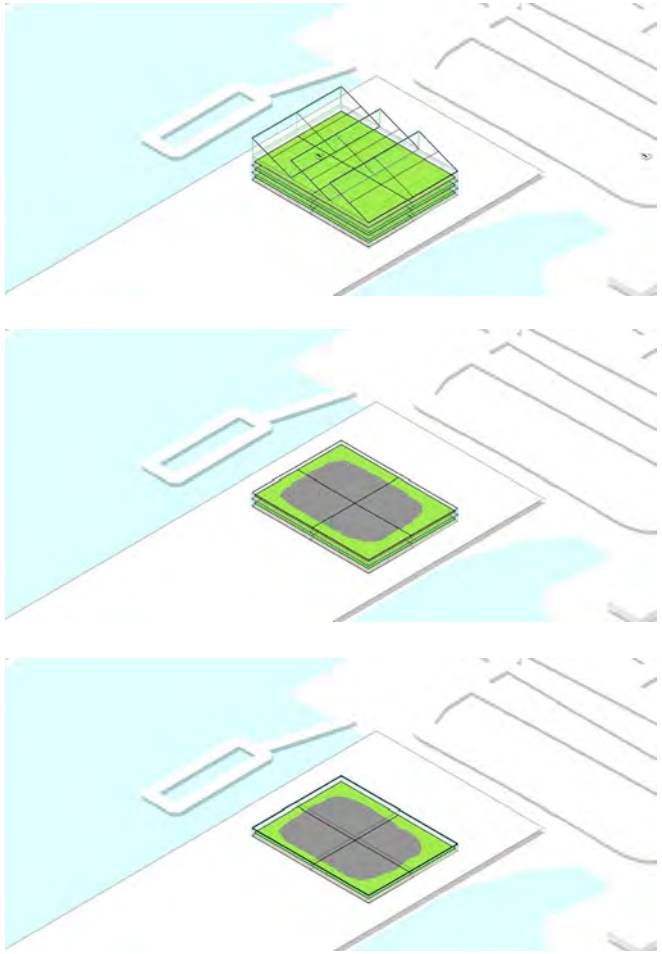


Atrium Study

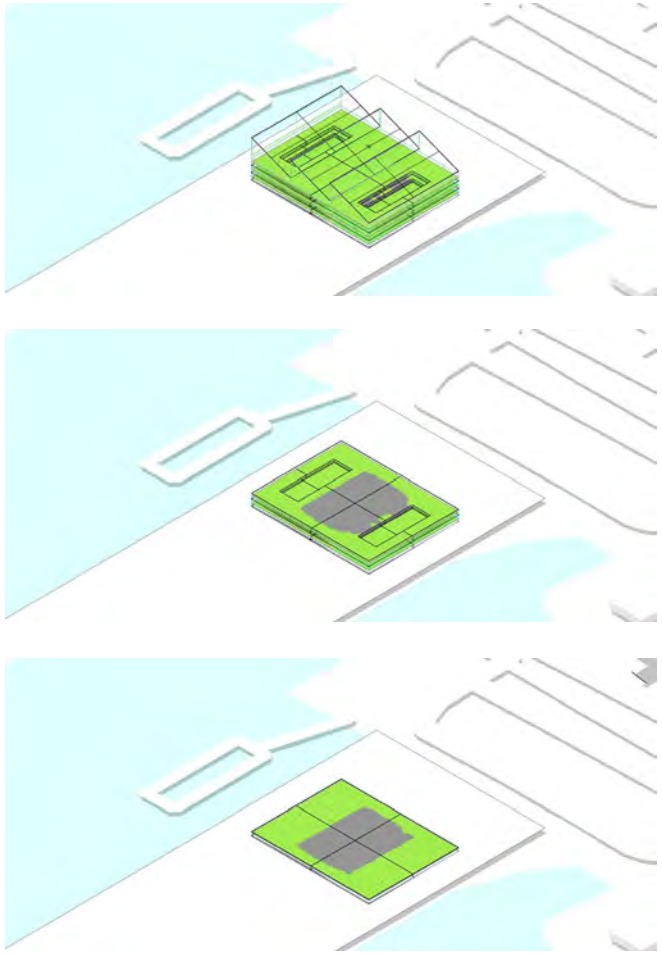


Centro de Investigaction, H Arquitects. https://www.archdaily.cl/cl/767655/centro-de-investigacion-icta-icp-star-uab-h-arquitectes-plus-dataae/5567b61de58ecebd7a0000ae-centro-de-investigacion-icta-icp-star-uab-h-arquitectes-plus-dataae-foto

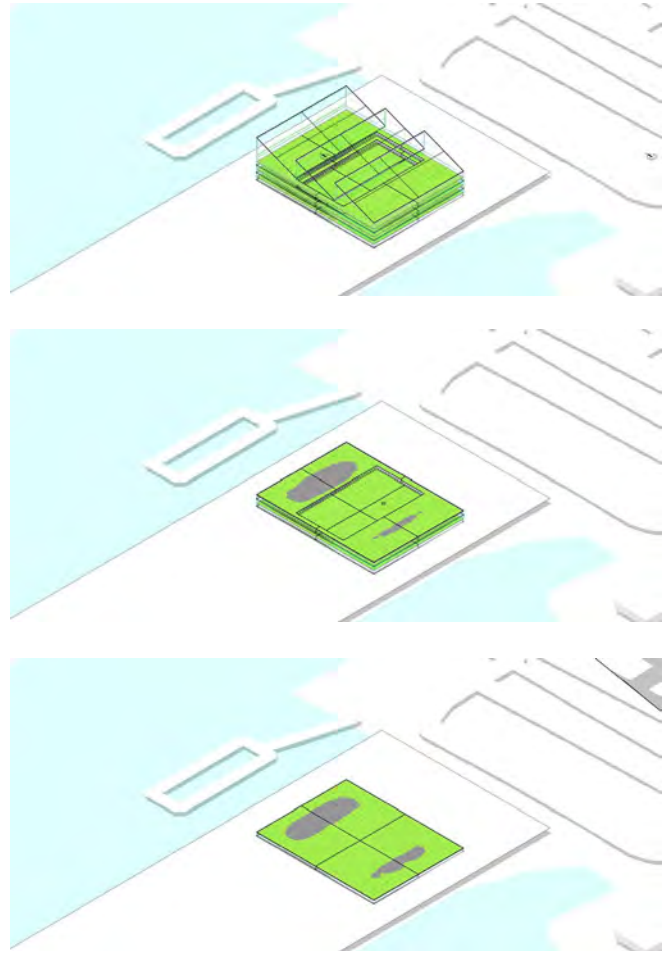
Atrium Daylight Autonomy Study



sDA = 59.8%
ASE = 13%

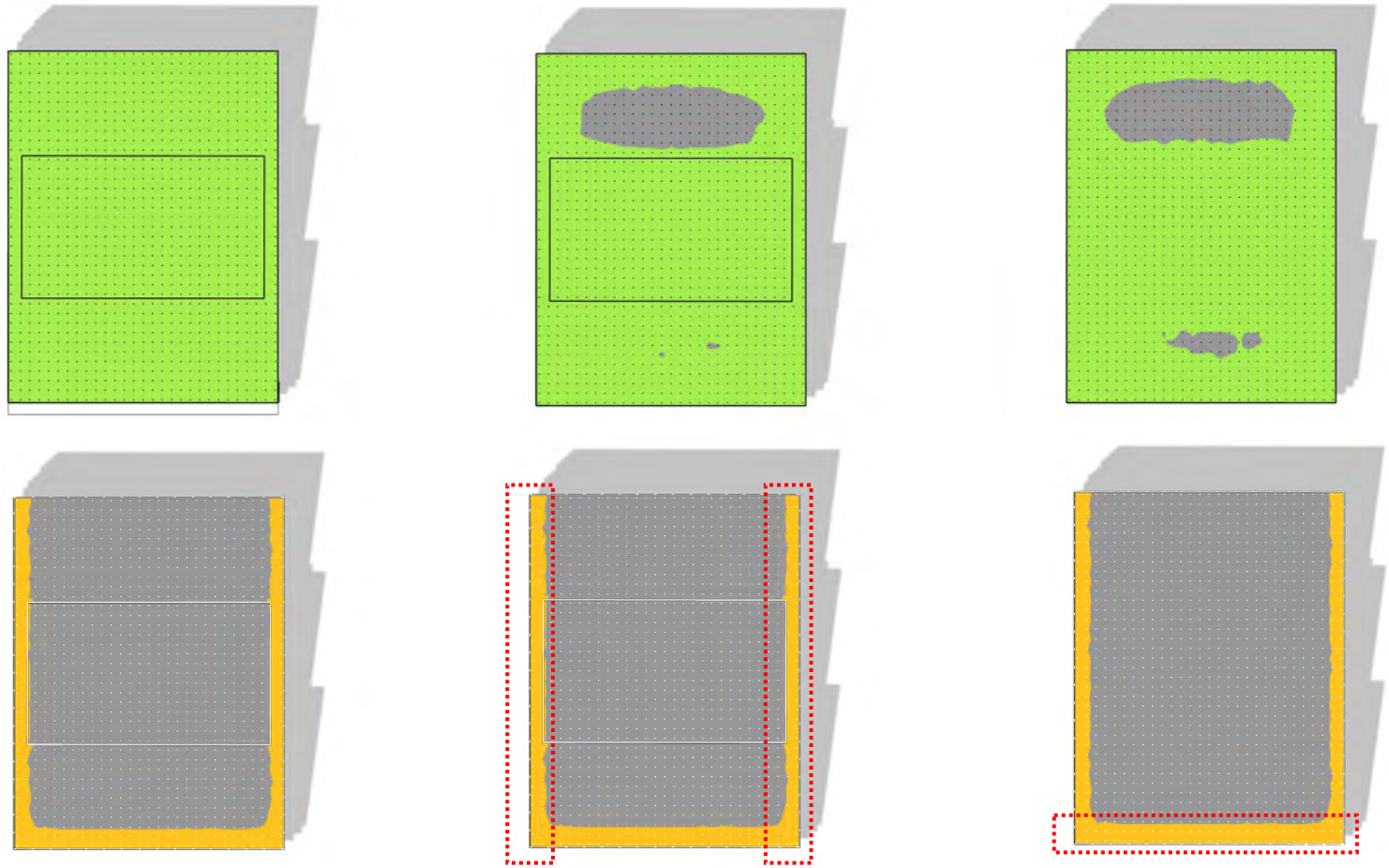


sDA = 75.7%
ASE = 12.4%



sDA = 87.1%
ASE = 14.7%

Annual Solar Exposure



89.8%
$sDA_{300/50\%}$

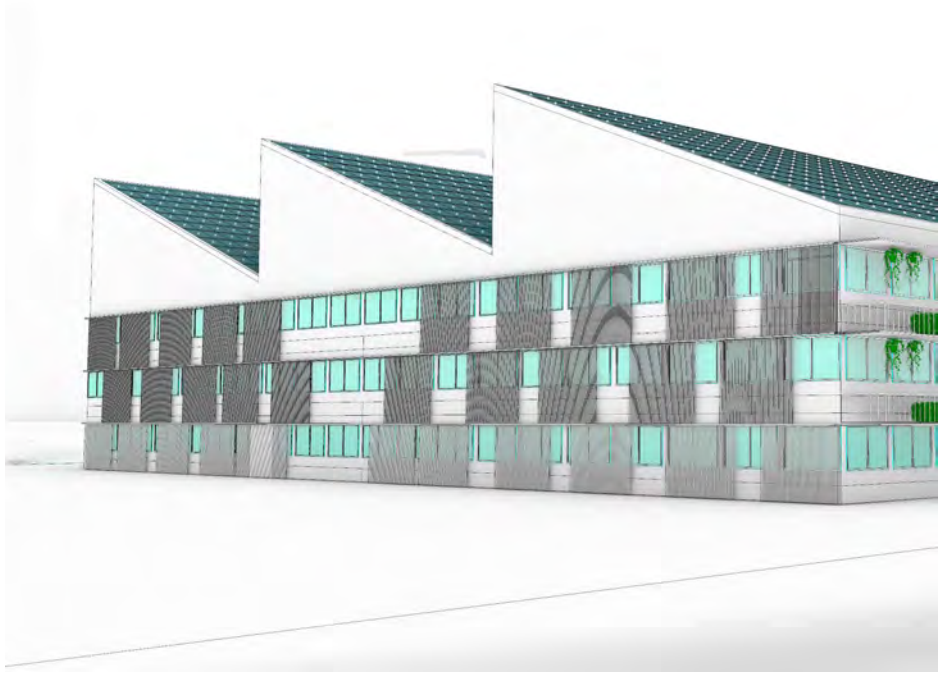
22.0%
$ASE_{1000,250}$

1st Floor

2nd Floor

3rd Floor

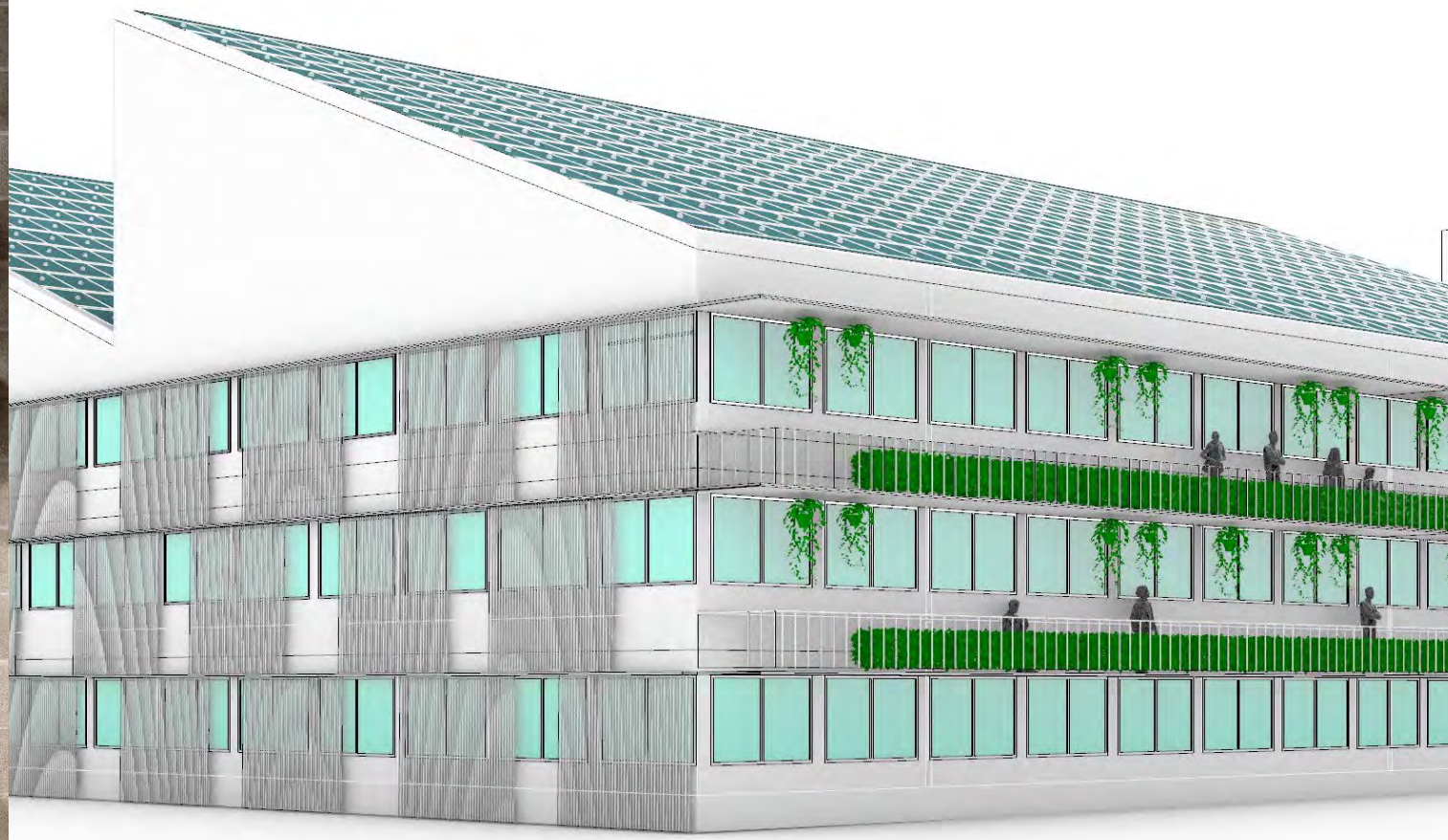
Façade Shading Study



-Vertical shading panels on the East and West facades
-Targeting glare probability resulting from low sun in the mornings/afternoon

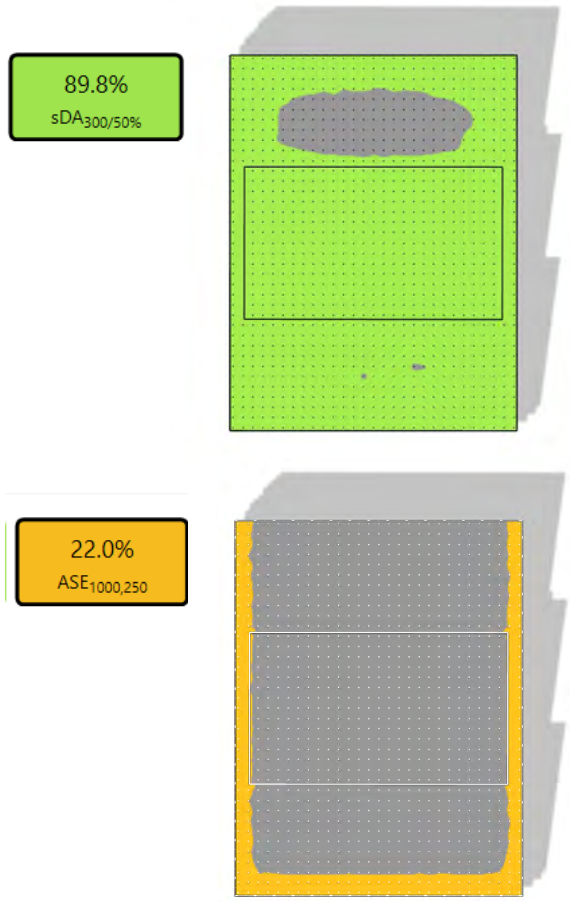
-Horizontal shading light shelves on the south facade
-Targeting glare probability resulting from high sun angles

Low-tech rolling shading device

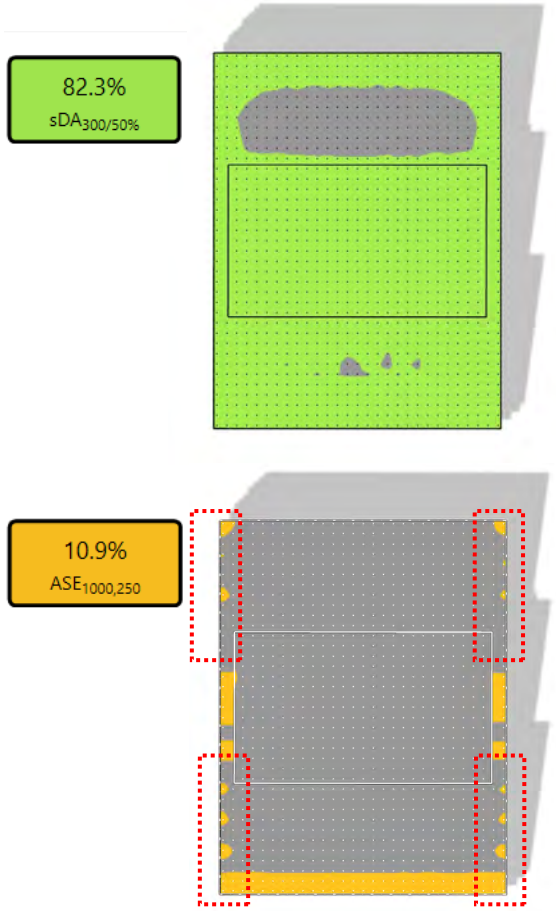


Façade Shading Study

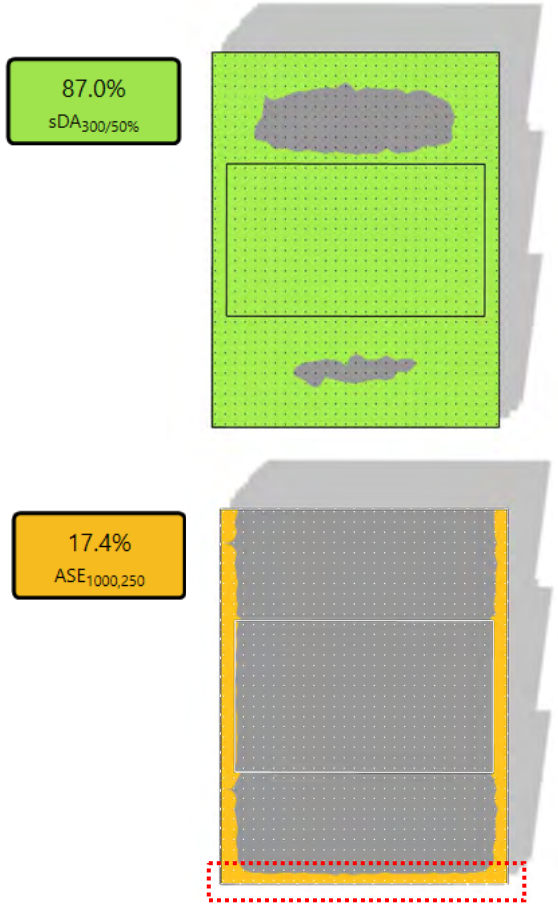
No Shading



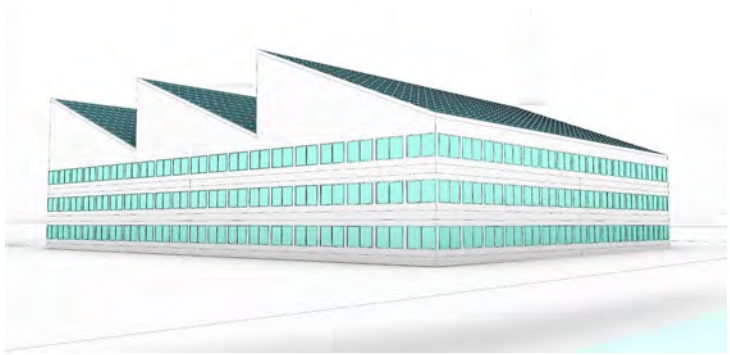
EW Shading Panels

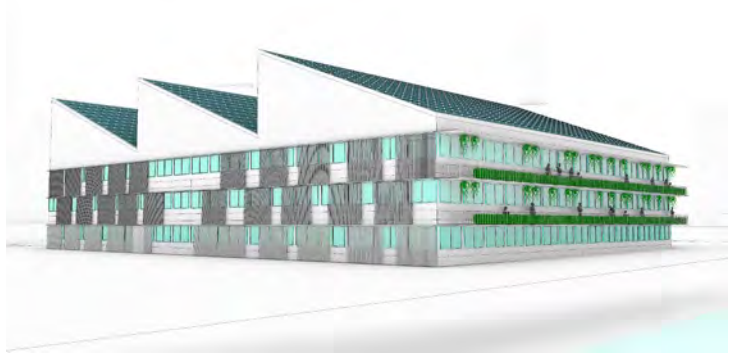


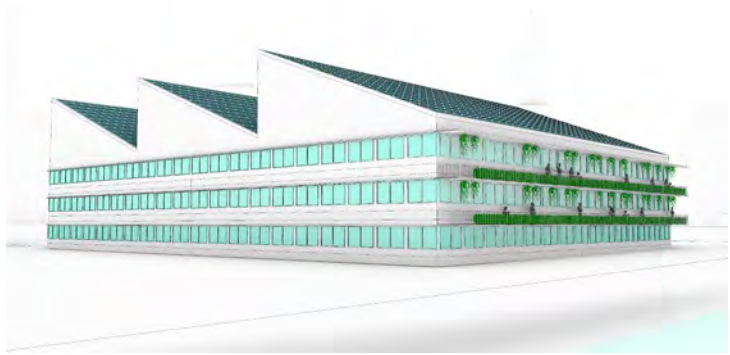
S Light Shelves

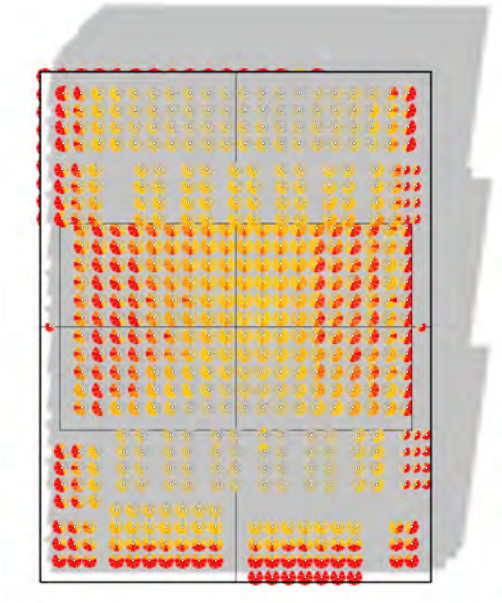


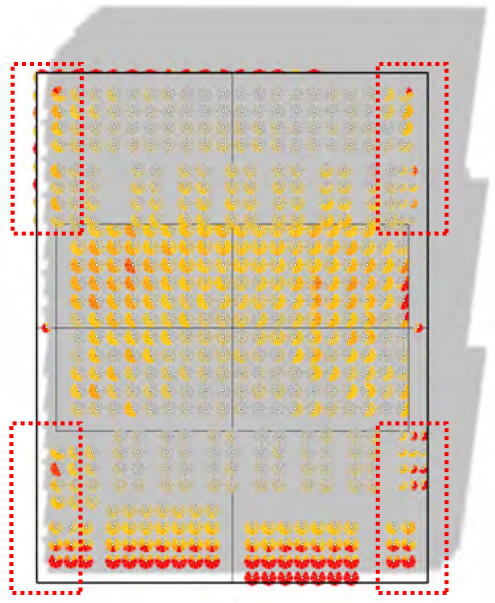
Glare Study

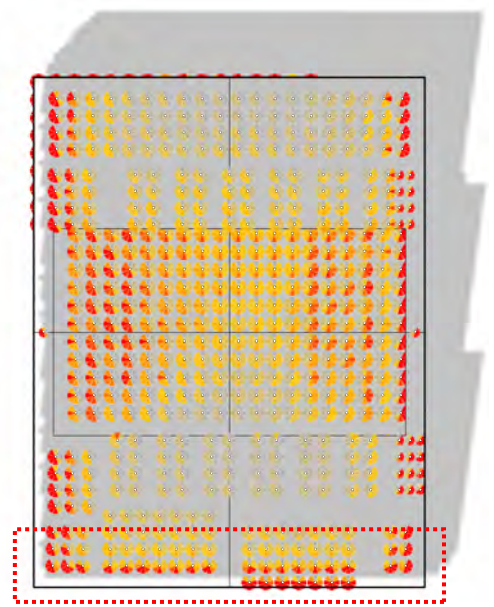












17.9%
sDG (% views with Disturbing Glare >5% of time)

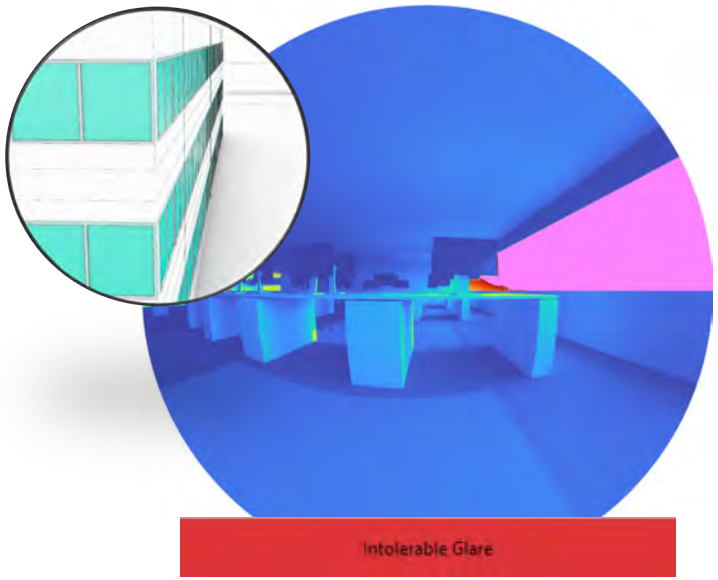
9.9%
sDG (% views with Disturbing Glare >5% of time)

13.3%
sDG (% views with Disturbing Glare >5% of time)

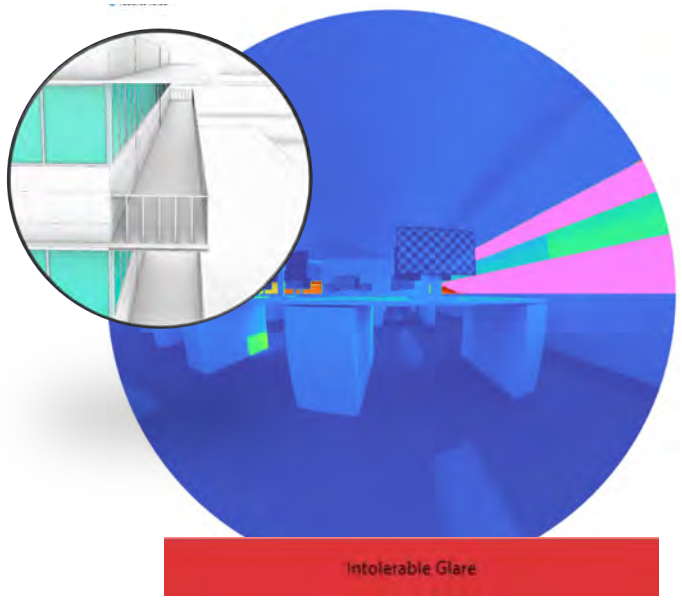
South Facade Workspace

South facing open-office space without any shading or light shelves

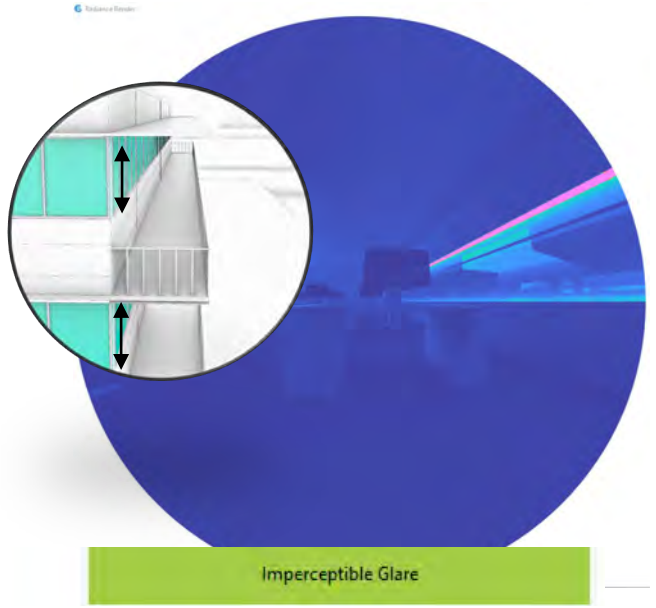
>2500 cd/m²



South facing open-office space with added light shelves



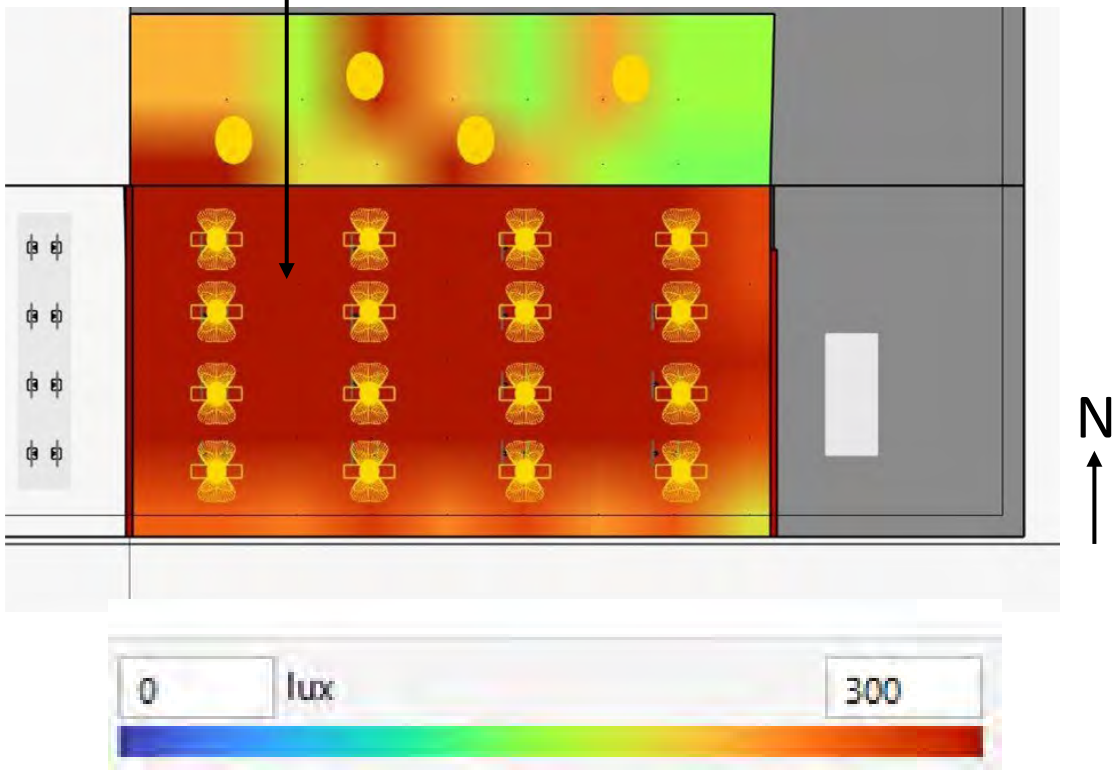
South facing open-office space with added **light shelves** and **operable shades**



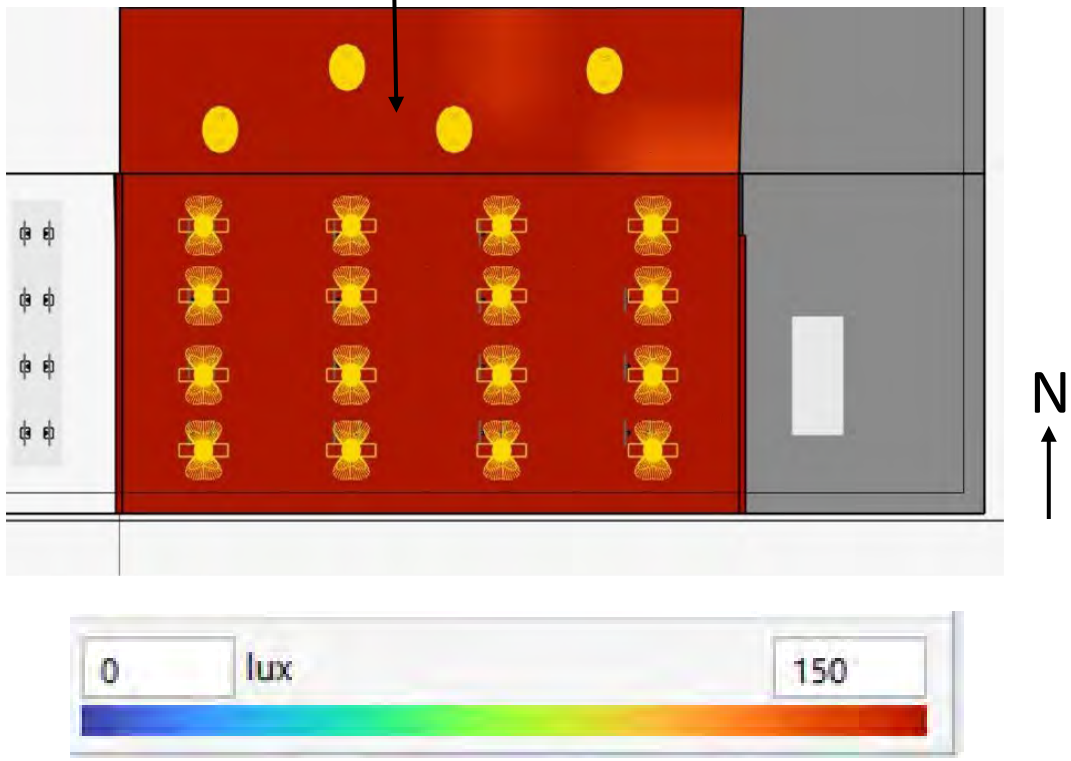
Nov. 13 at 11:00AM

LUMINAIRE PLACEMENT - CIRCULATION V WORKING

Working Area



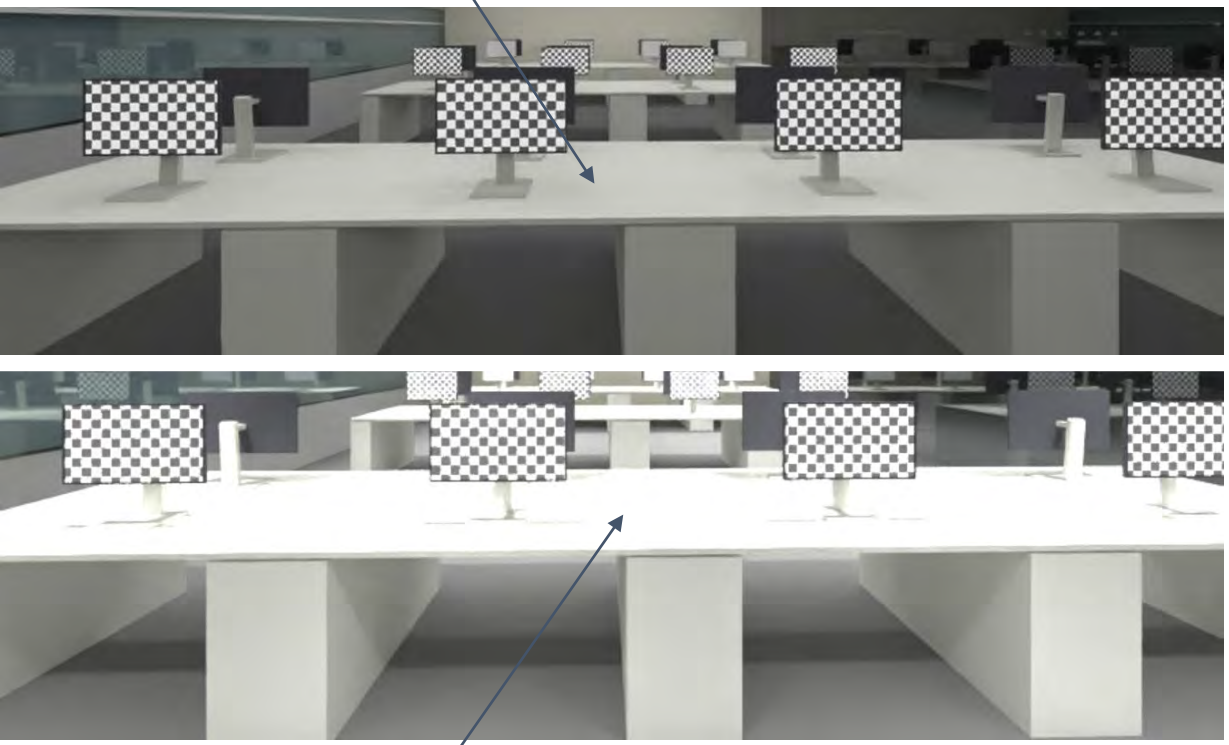
Circulation Area



- Enough lighting was spaced in the working and circulation area to achieve 300 lux and 150 lux respectively
- These analyses were performed at 10pm when there is no daylight

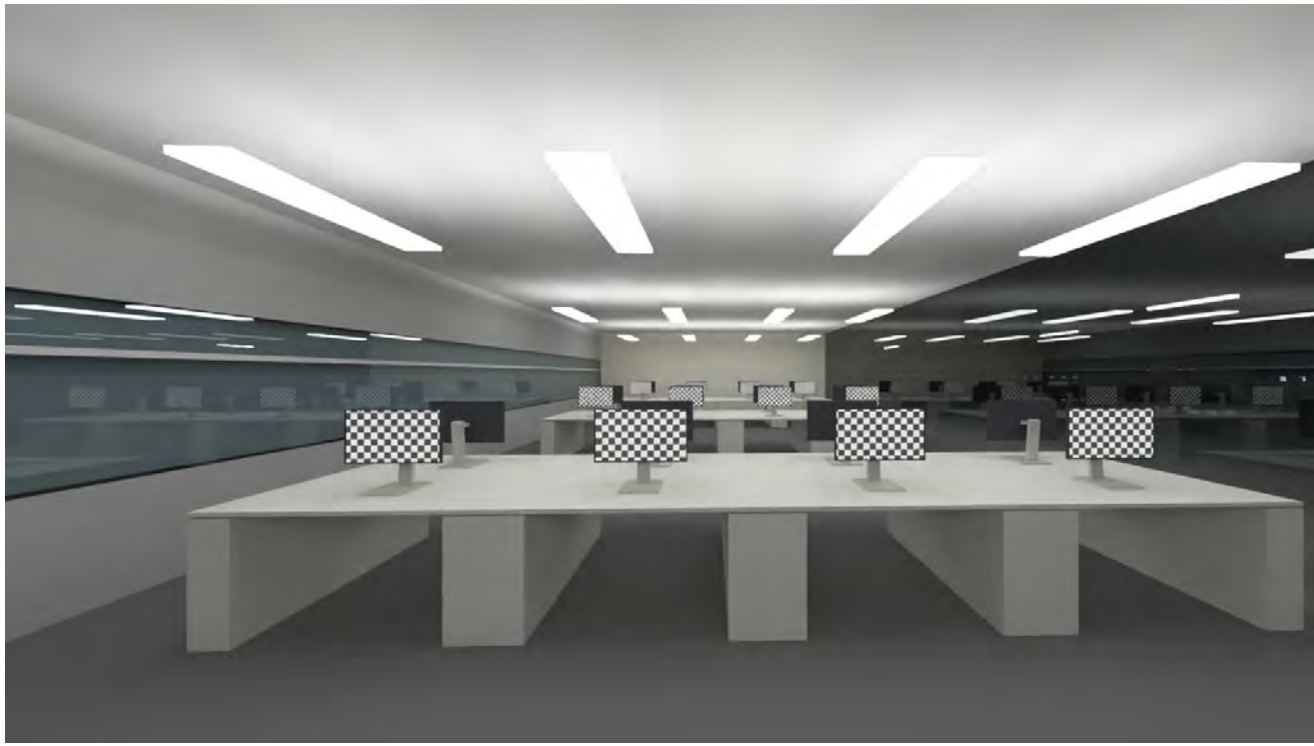
LUMINAIRE PLACEMENT - INDIRECT V DOWNLIGHT

Direct/Indirect Lights in the working space space



Dowlighs in the working space

Final Design: Direct/Indirect Lights in the working space



- On the left we see the effects of the two different types of lighting on the lighting at the desk/working level
- The downlights create more intense downshadows while the direct/indirect lights create more evenly distributed results

Lighting Power Density LPW Calculation

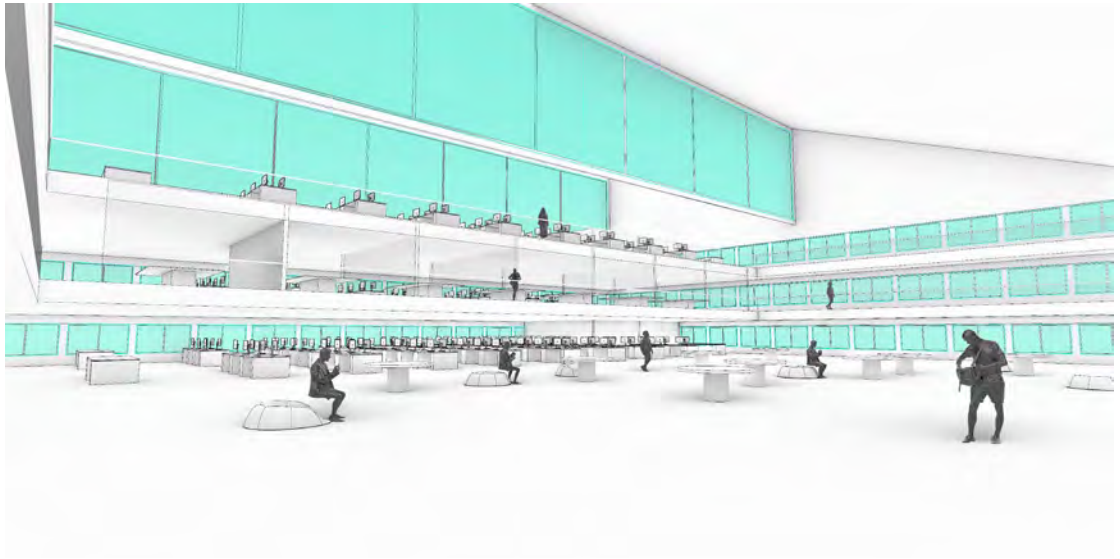
LPW Workspace		
Total area	122	m^2
Number of Luminaires	16	-
Wattage of each Luminaire	29	W
LPW Workspace	3.80	W/m^2
LPW Circulation		
Total area	60	m^2
Number of Luminaires	4	-
Wattage of each Luminaire	24	W
LPW Circulation	1.6	W/m^2

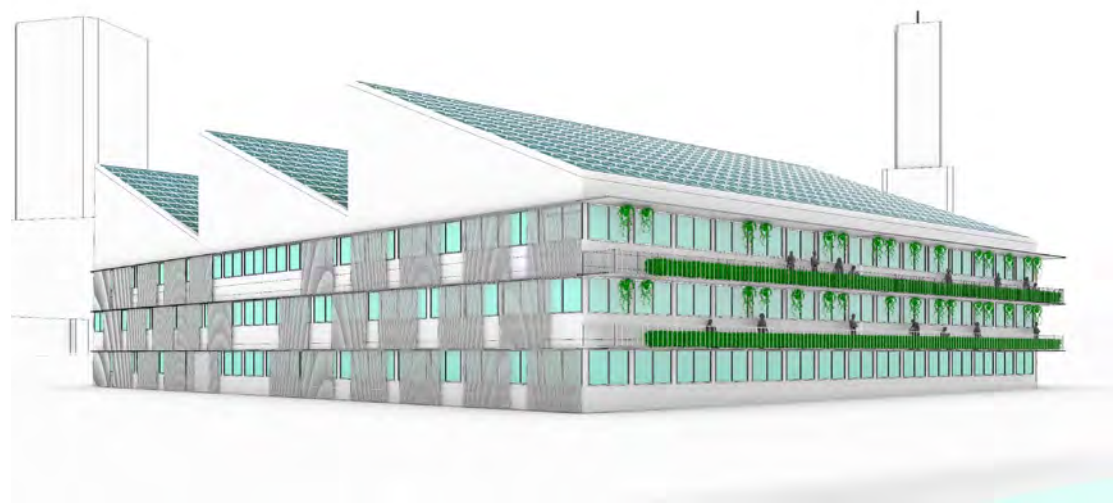
(29*16 / 122)

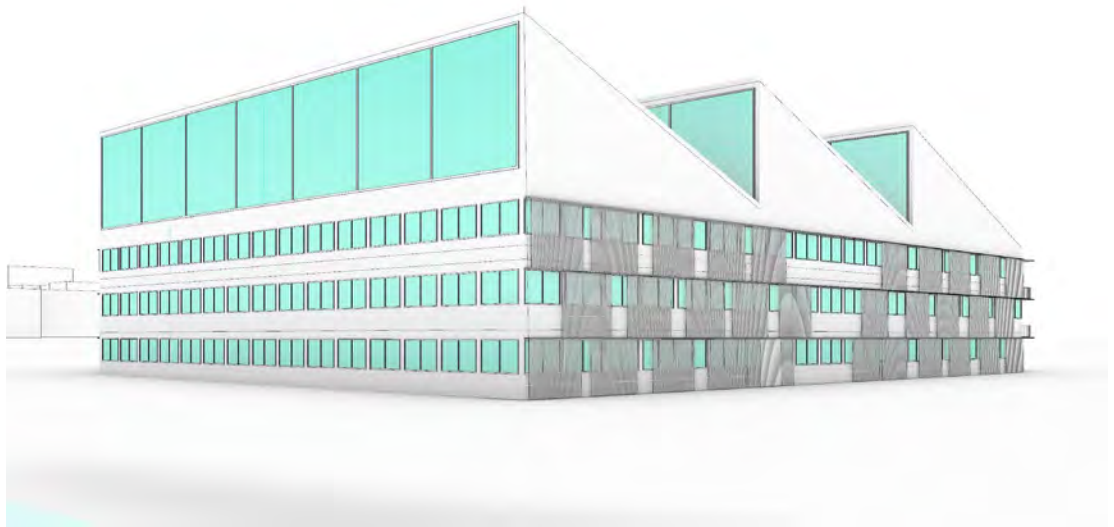
(24*4 / 60)

(24*4+29*16) / (60+122)

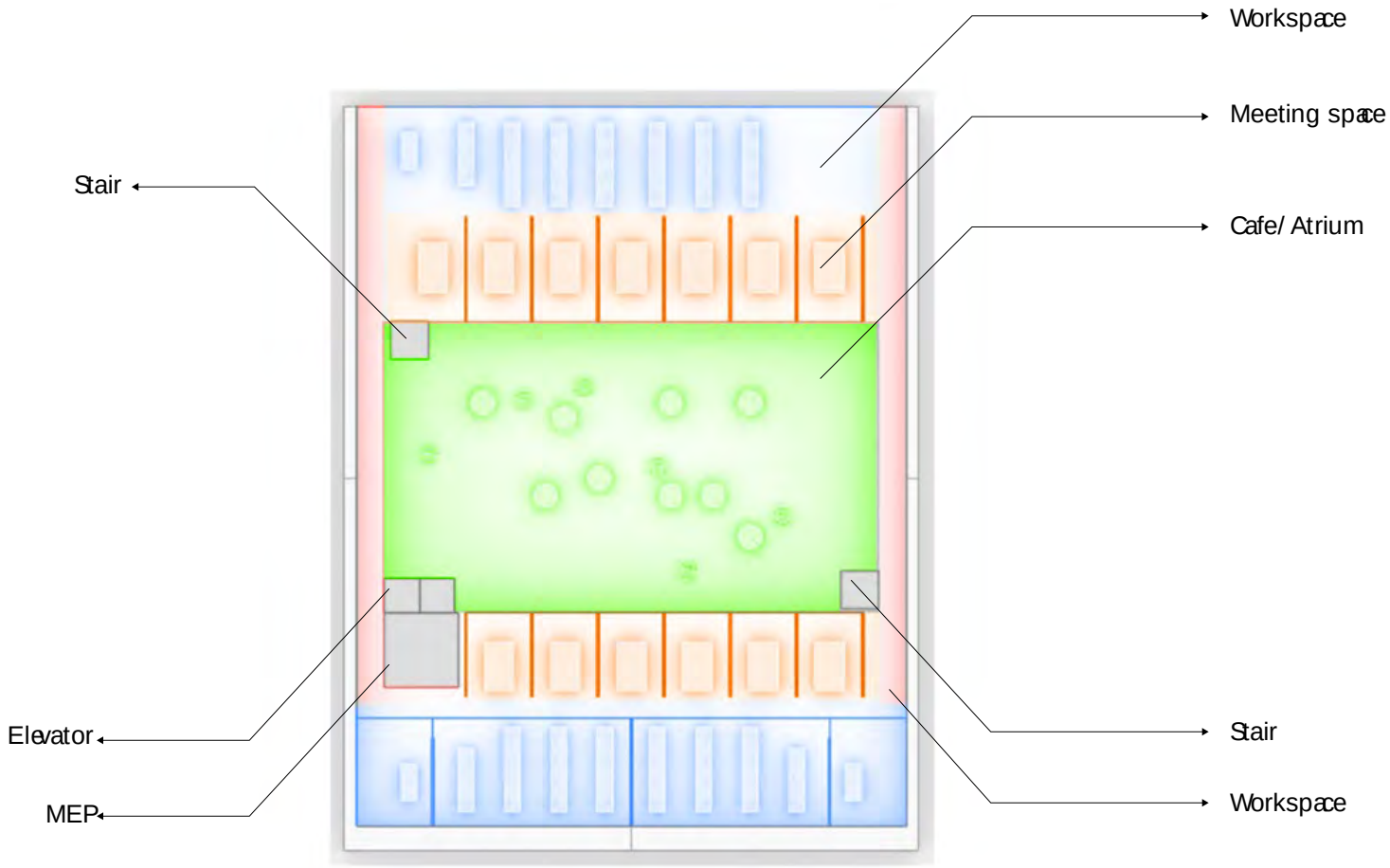
LPW Overall	**3.077**	**W/m^2**





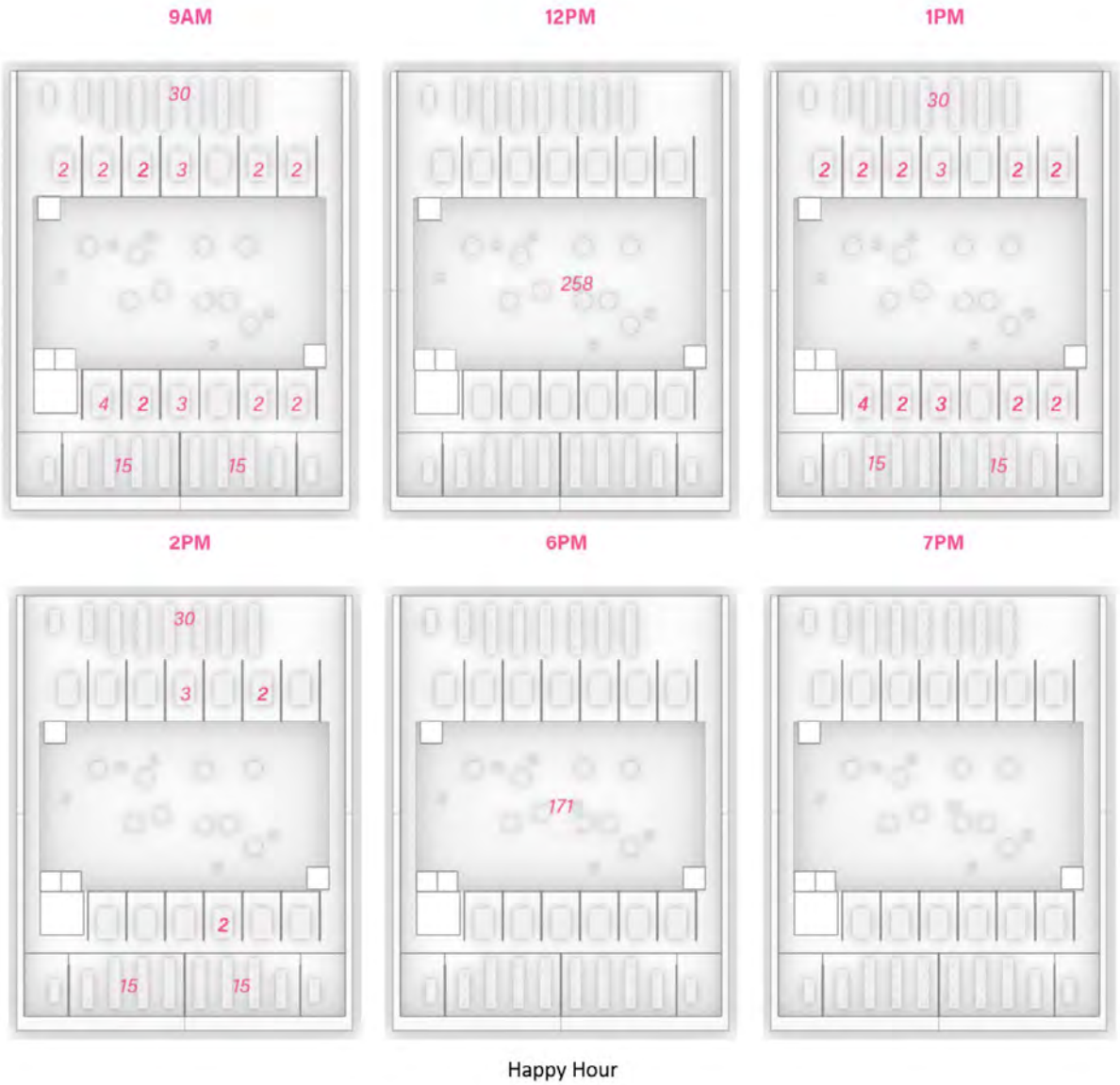


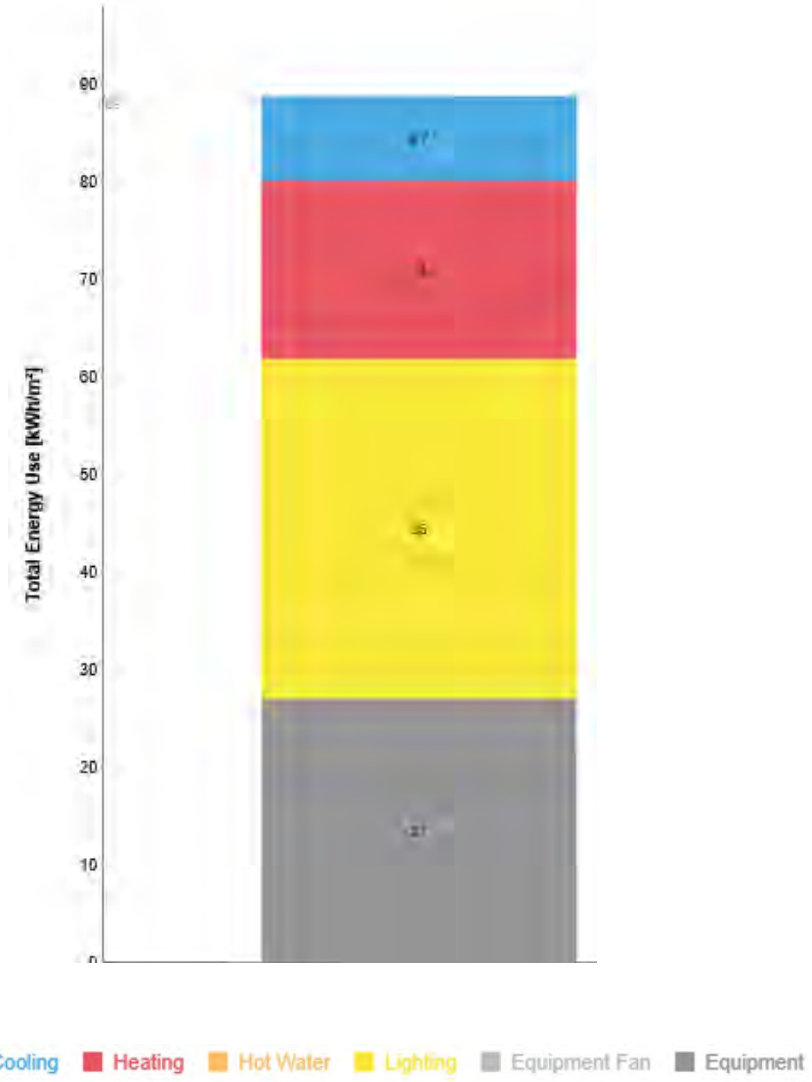
Typical Floorplan



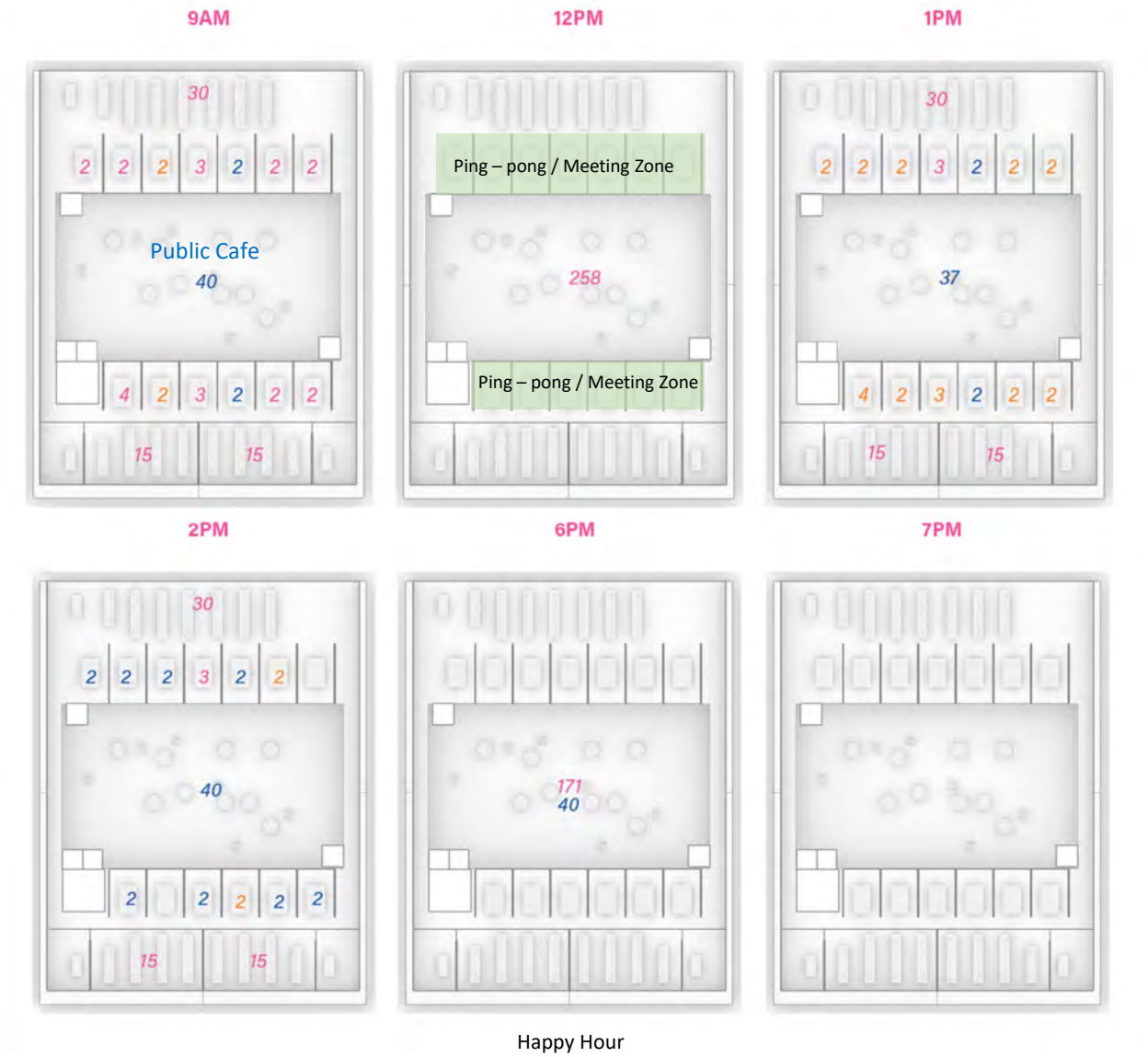
Environmental Concept I EUI

Occupancy and Schedule





Occupancy and Schedule – Ping Pong Concept

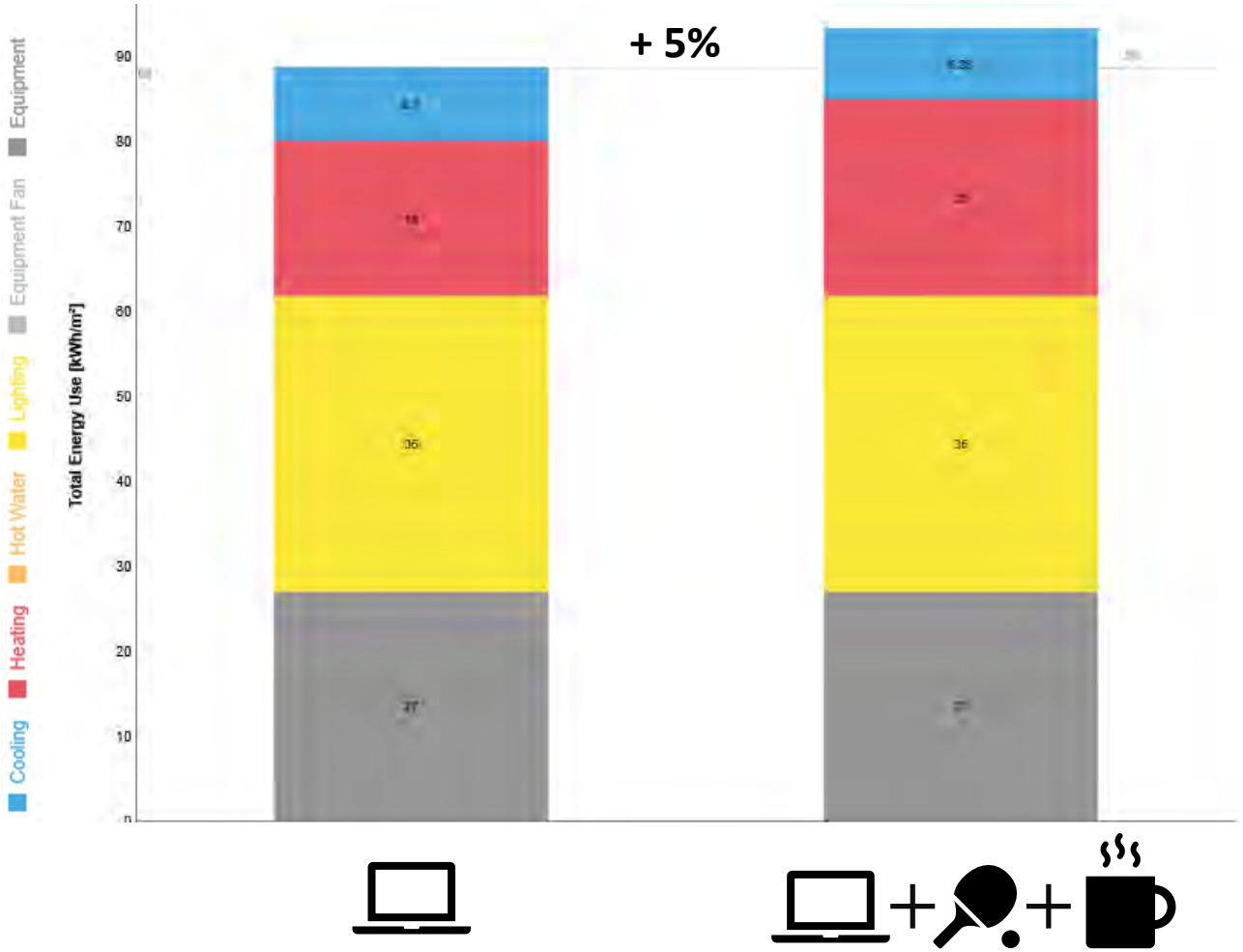


The Ping Pong/ Meeting Rooms can be used for ping pong or meetings/hot-desking by the employees. If they are free, they can be rented by visitors.

Workers
Workers playing ping pong
Visitors

EUI vs Energy Milage

EUI

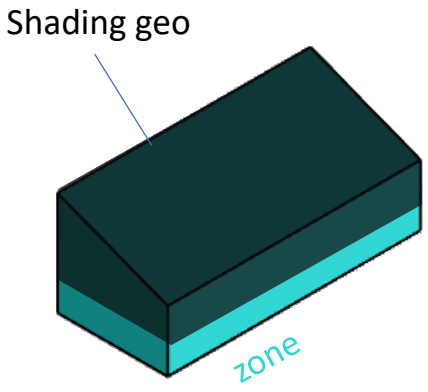


Energy Milage

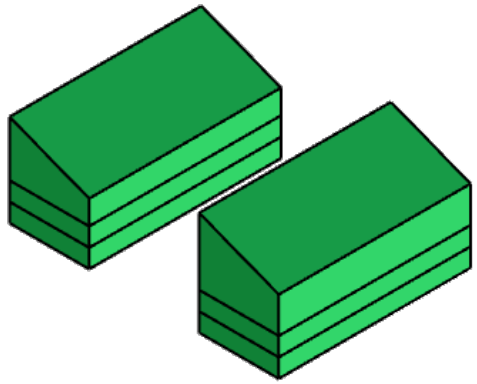
0.95 pers*h/kWh

1.15 pers*h/kWh

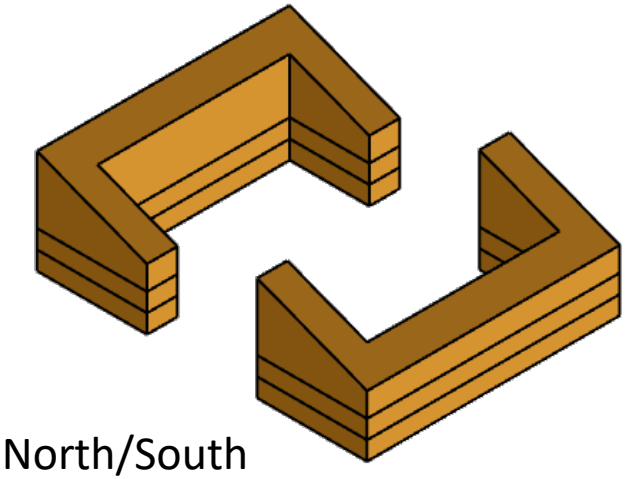
Thermal Zoning



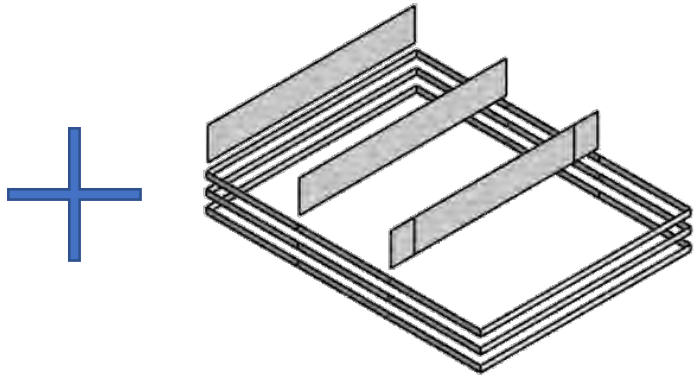
Internal atrium zone



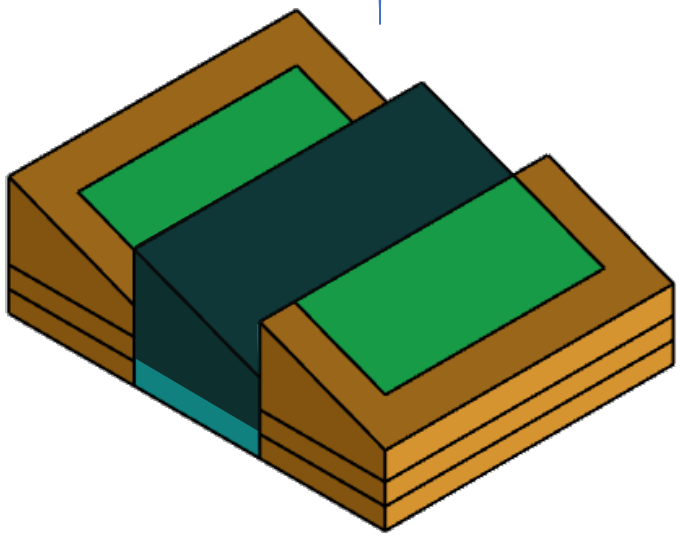
North/South core zones

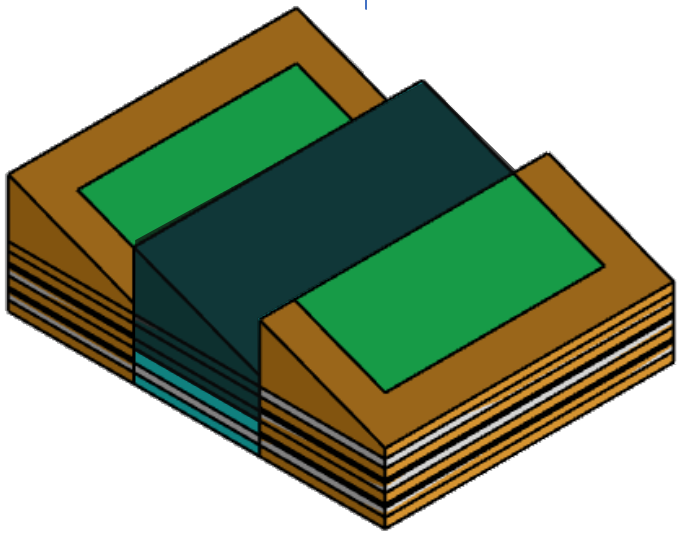


North/South perimeter zones

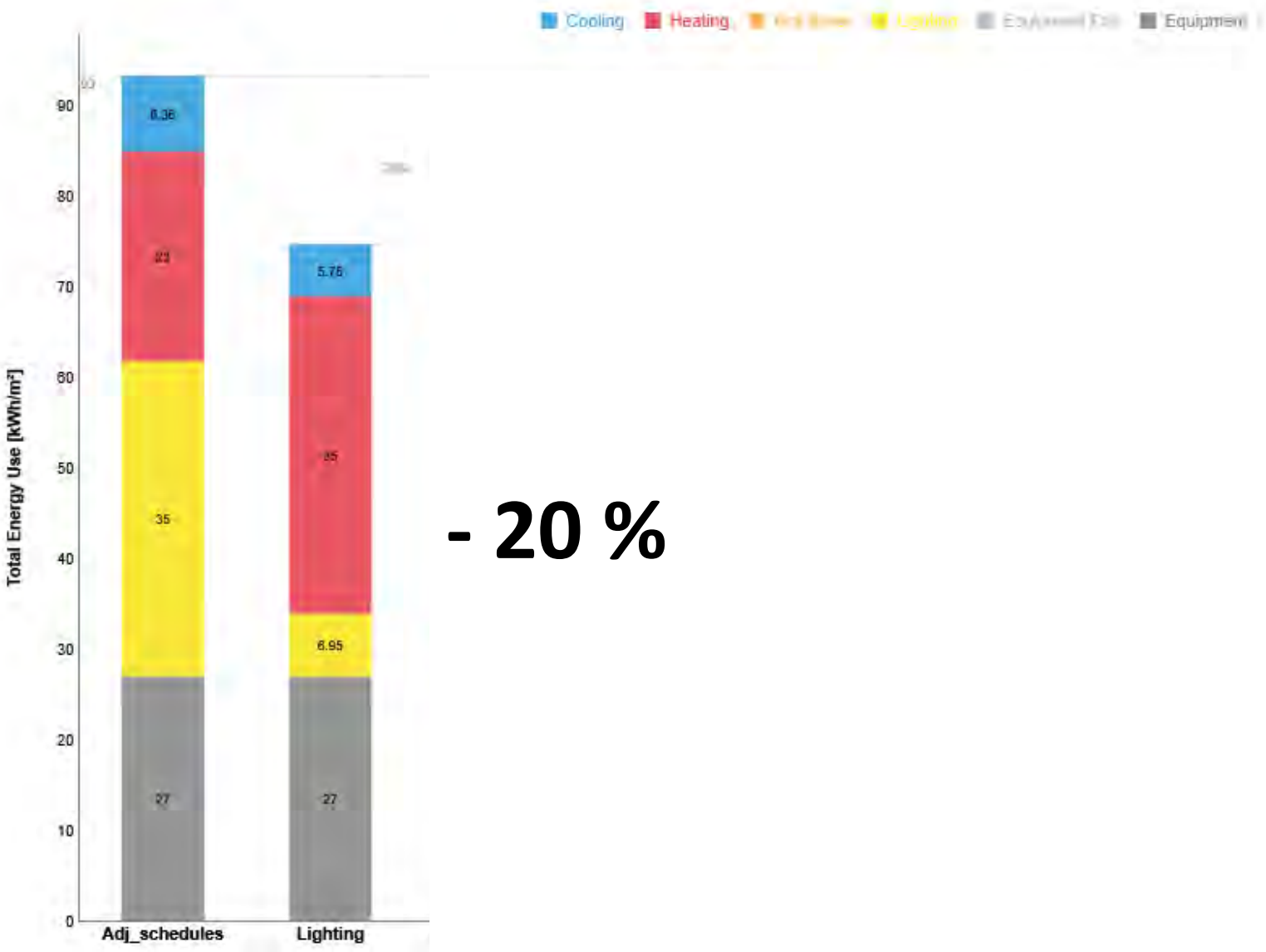


windows





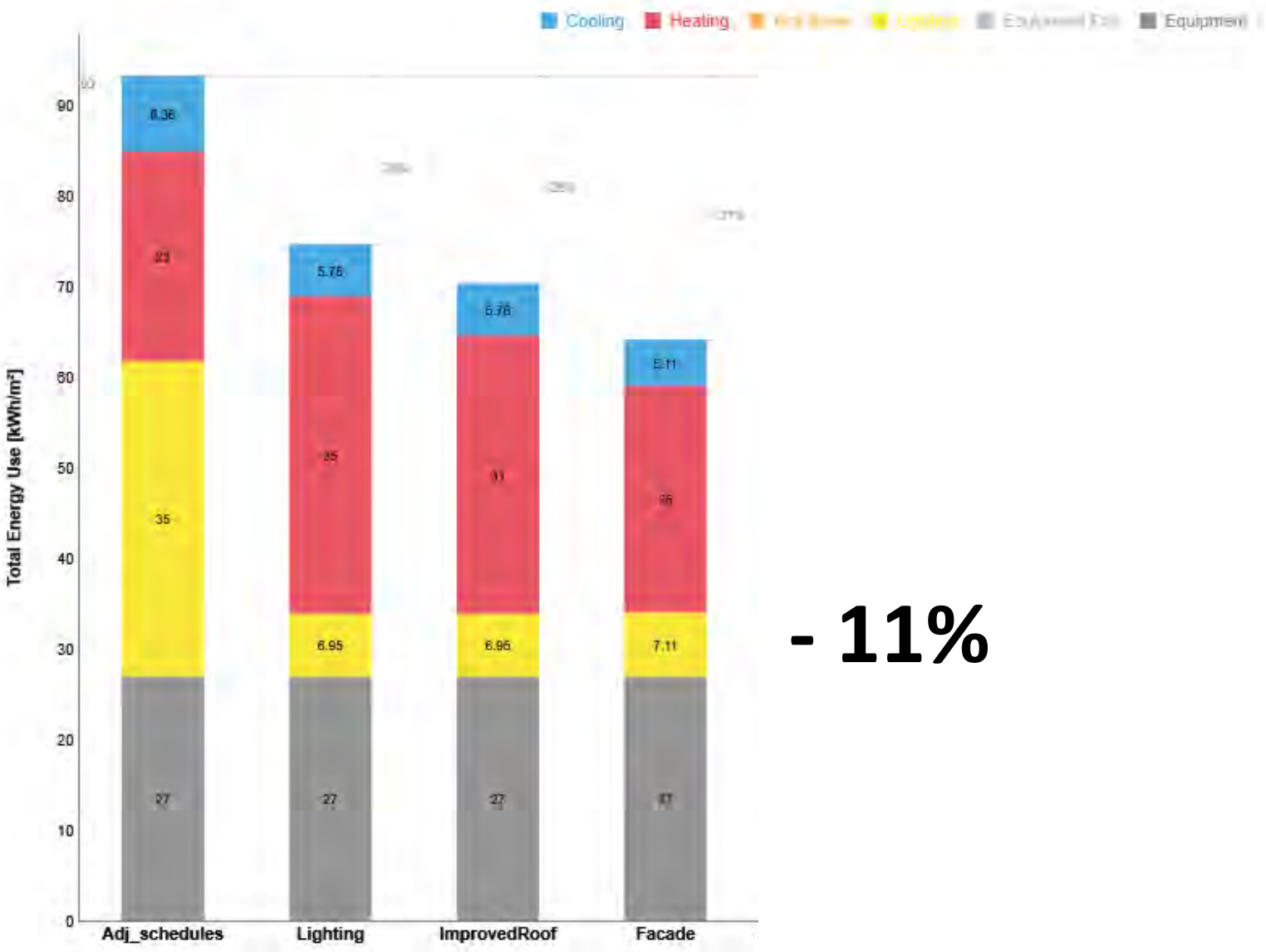
Lighting Adjustments



- 20 %

- Dimming
- LED Fixtures

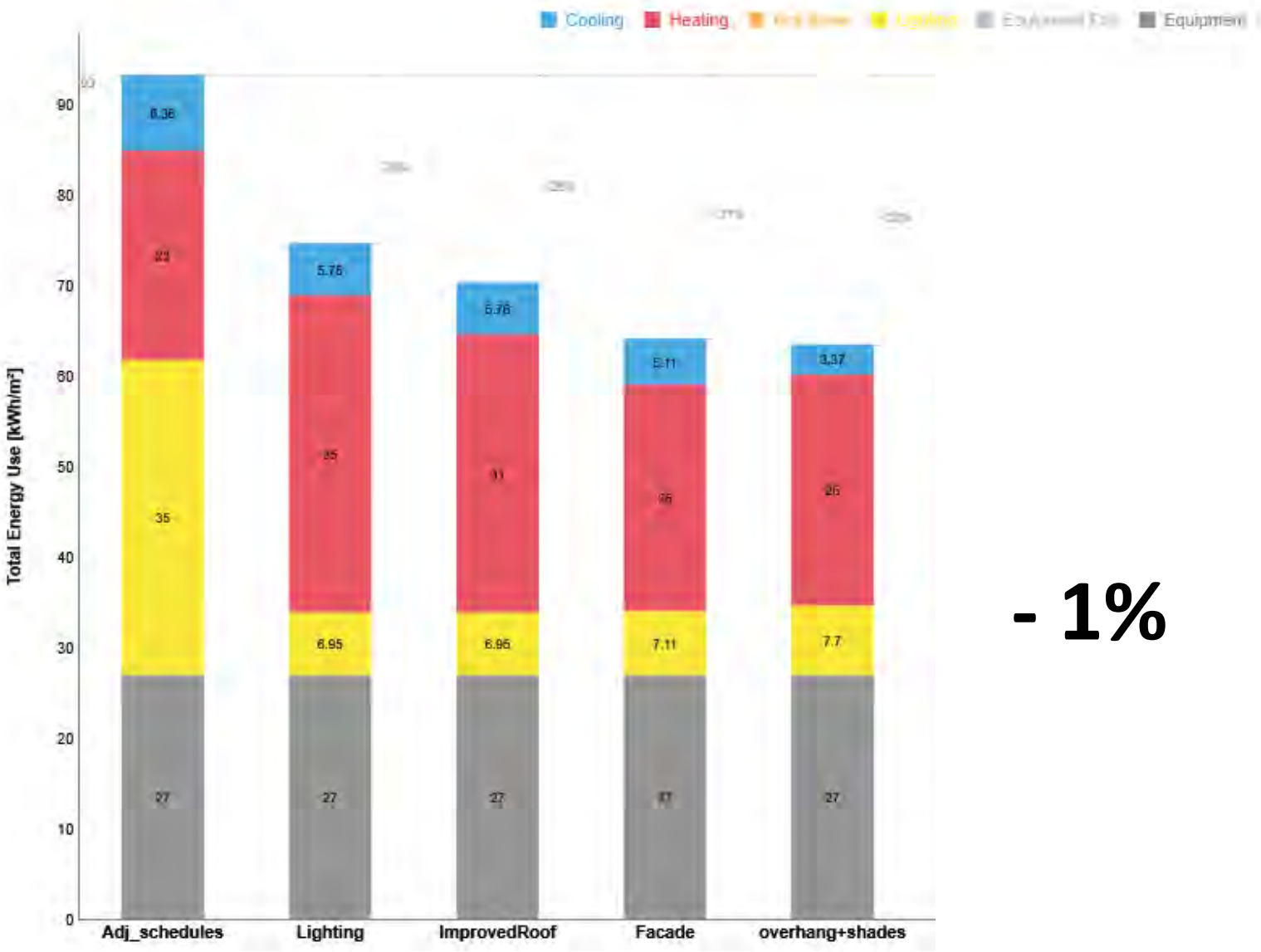
Added Insulation



- 11%

- Roof| 0.364 to 0.17 W/m2K
- Façade | 0.67 to 0.165 W/m2K

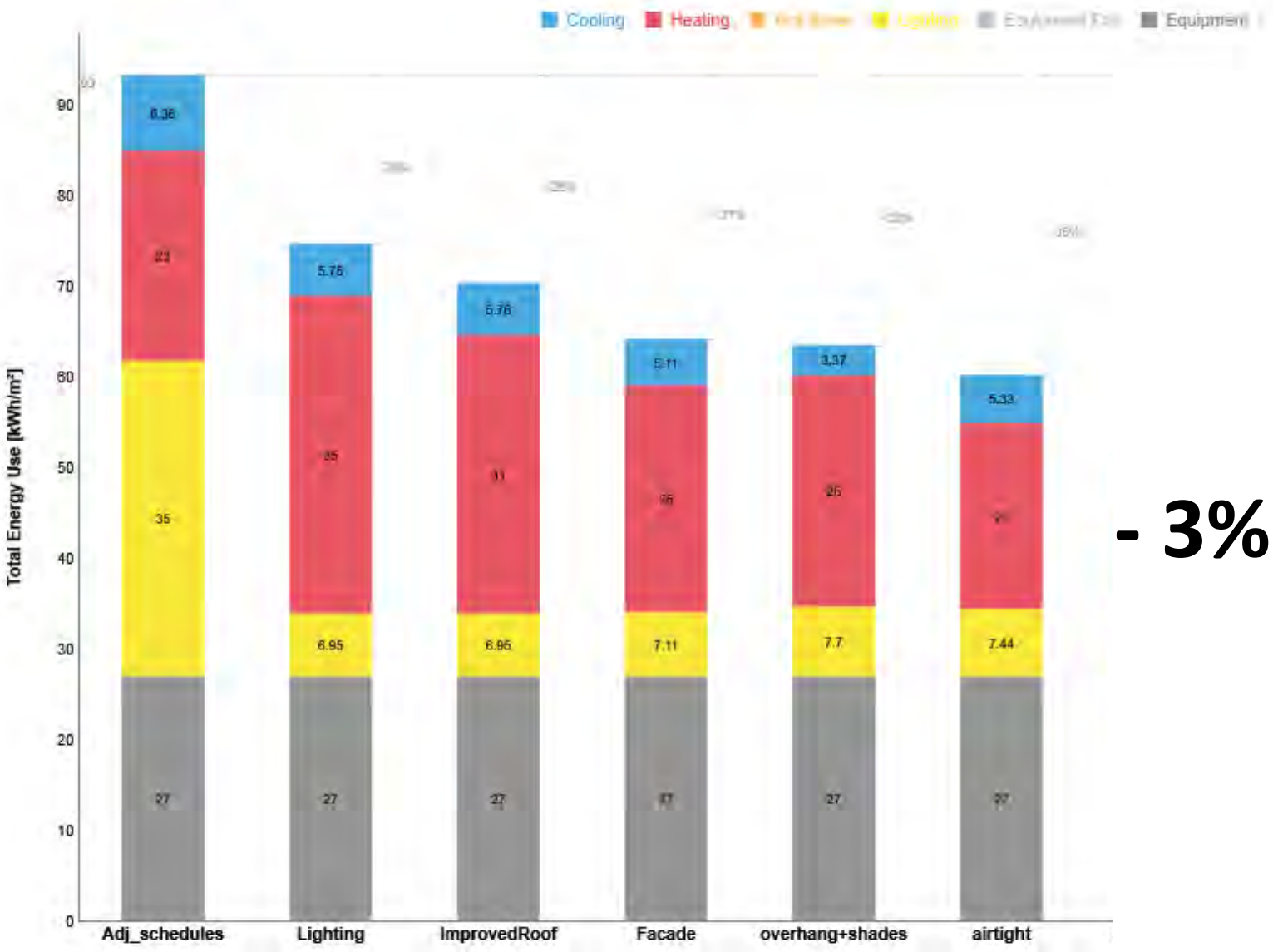
Shading System



- South balconies as overhang
- Manual exterior shading east and west

- 1%

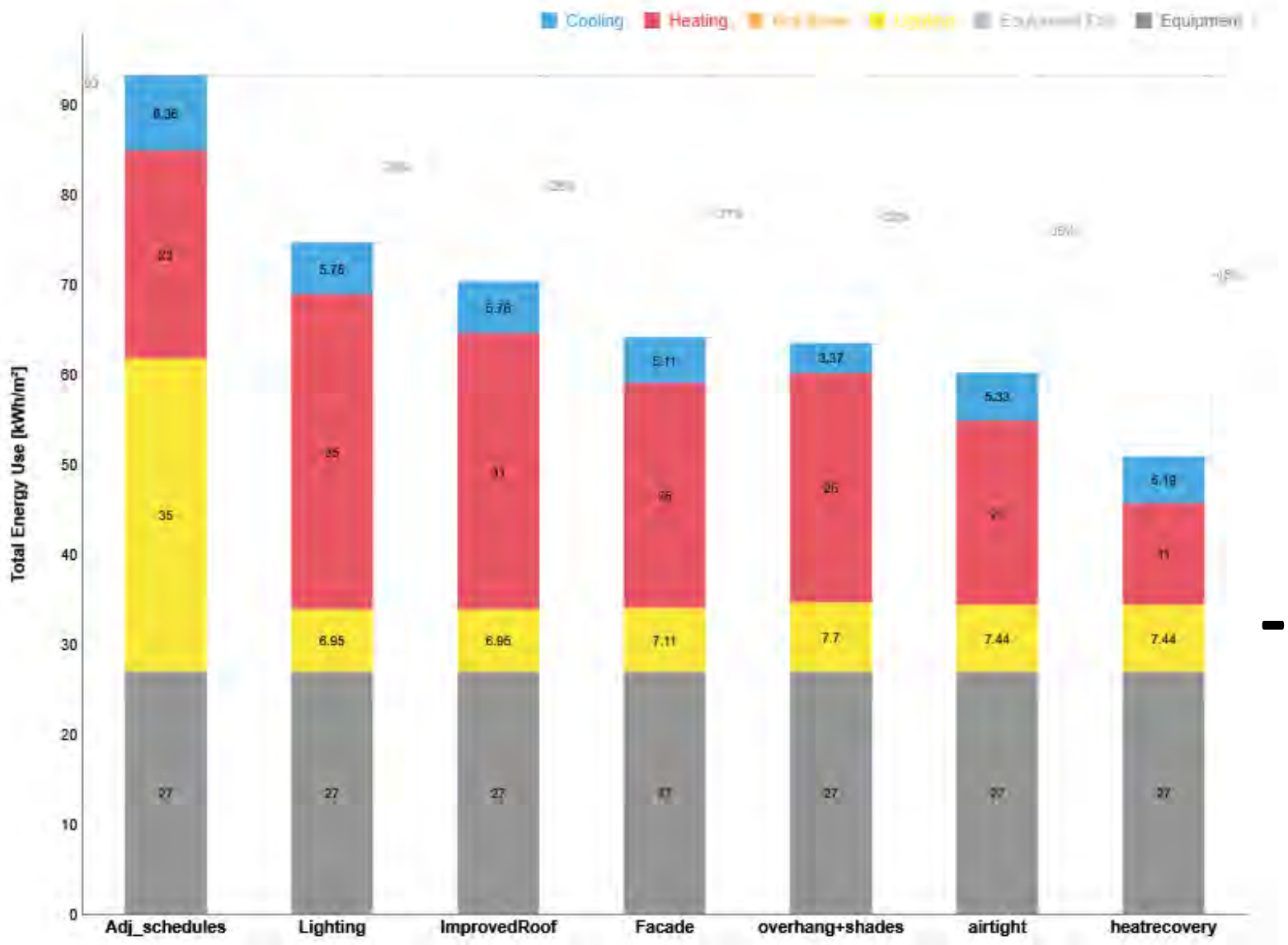
Tighten Envelope



- Infiltration | 0.1 to 0.05 ach

- 3%

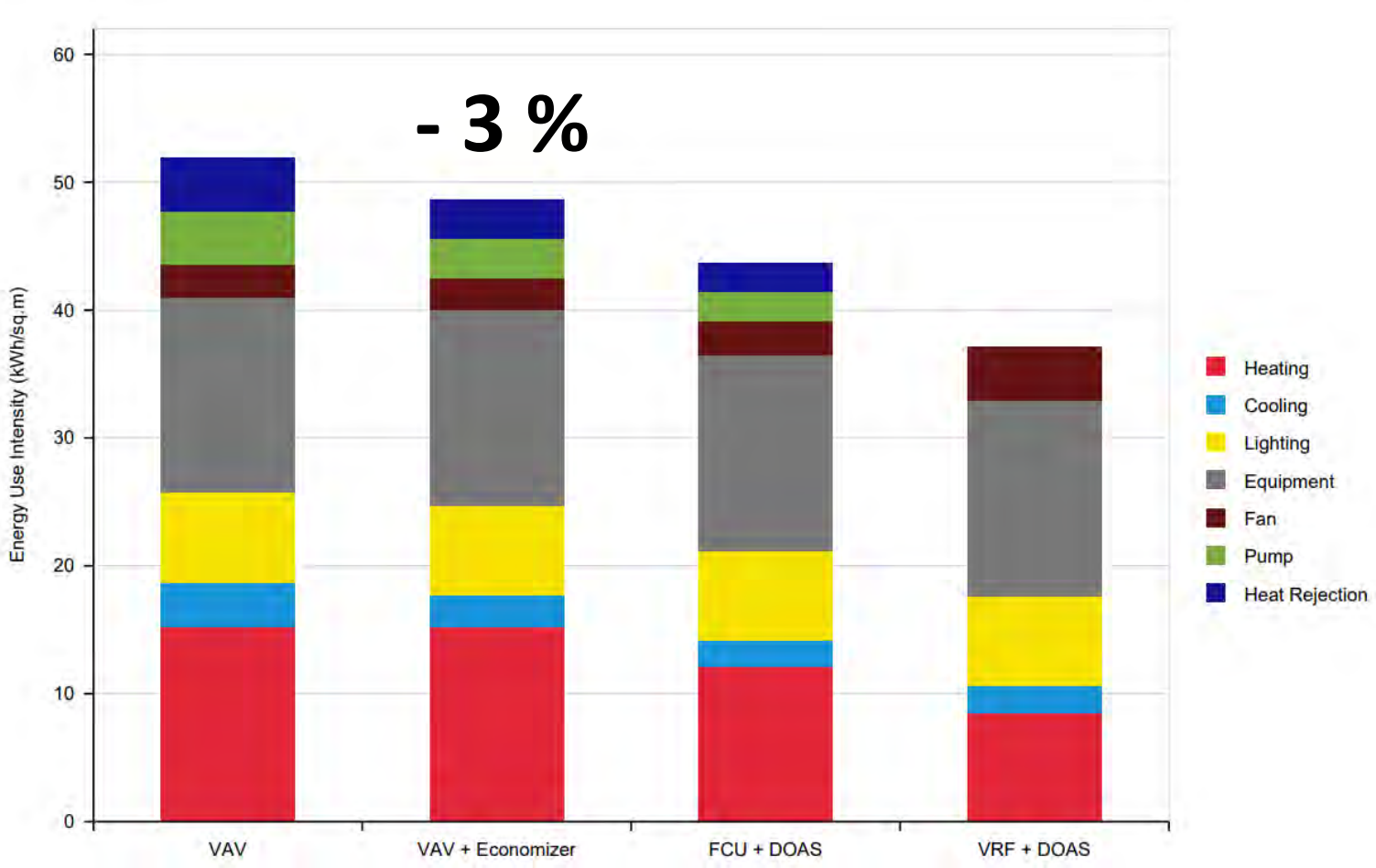
Heat Recovery



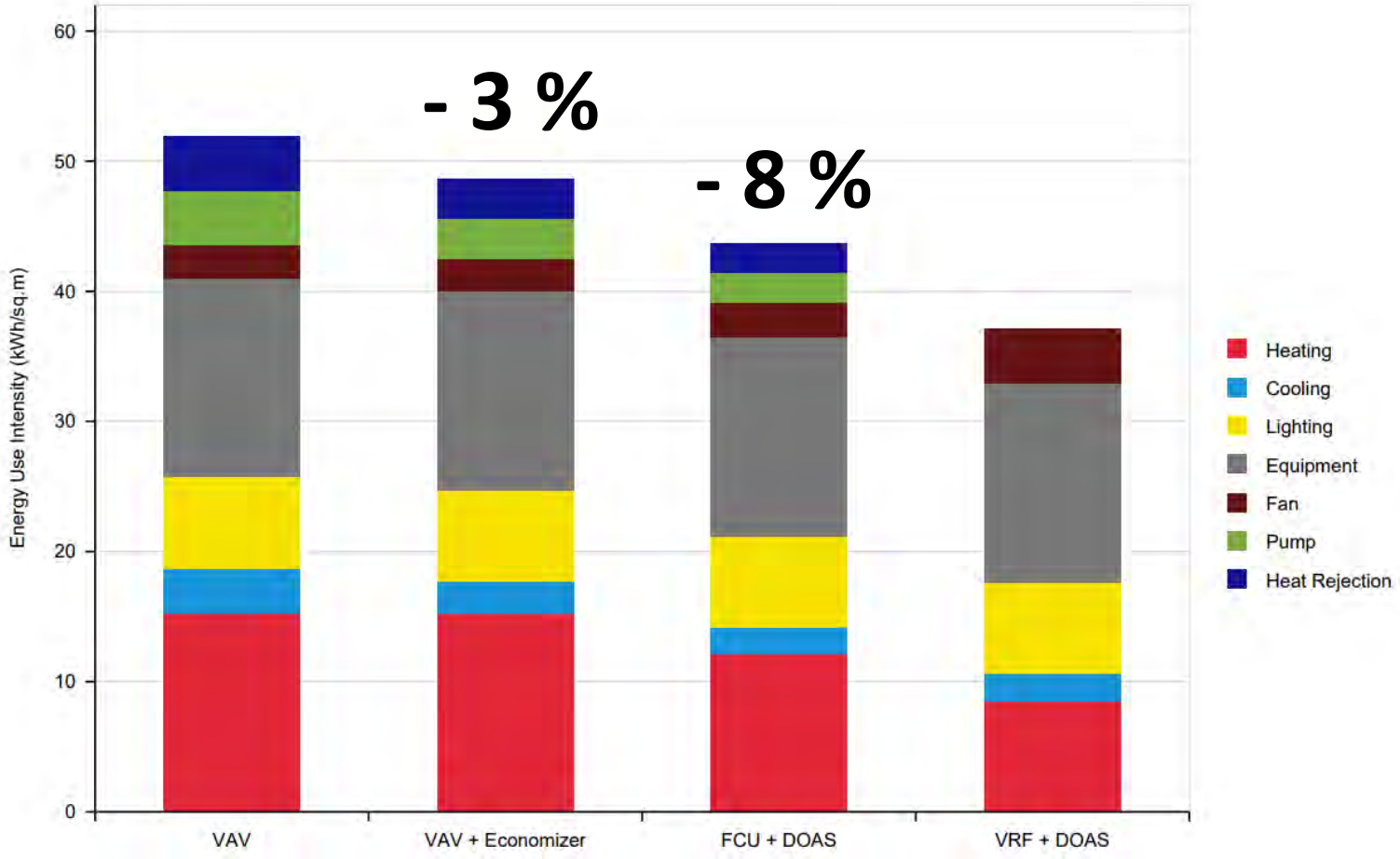
- Heat Recovery Efficiency | 0.8

- 10 %

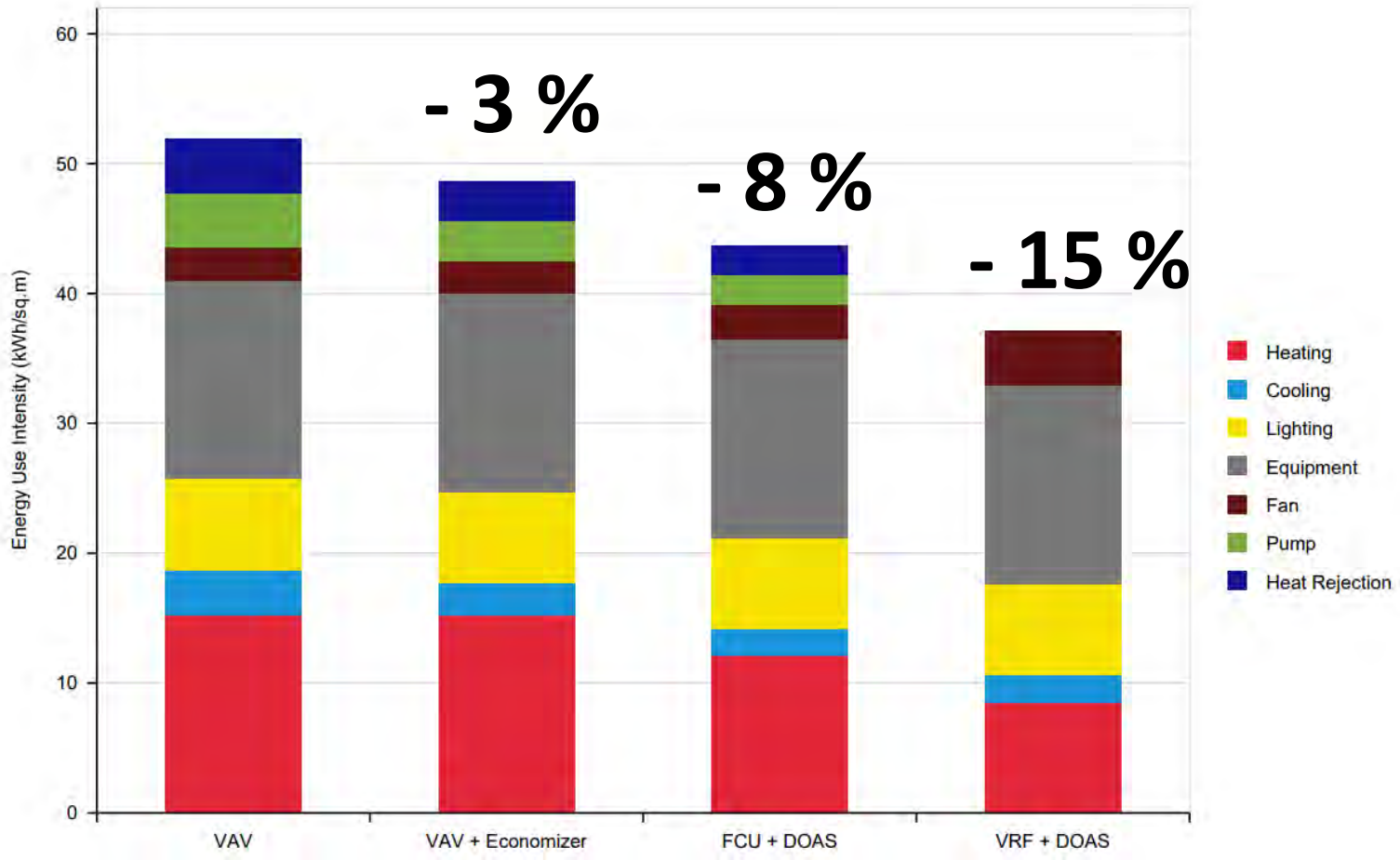
HVAC System Comparison



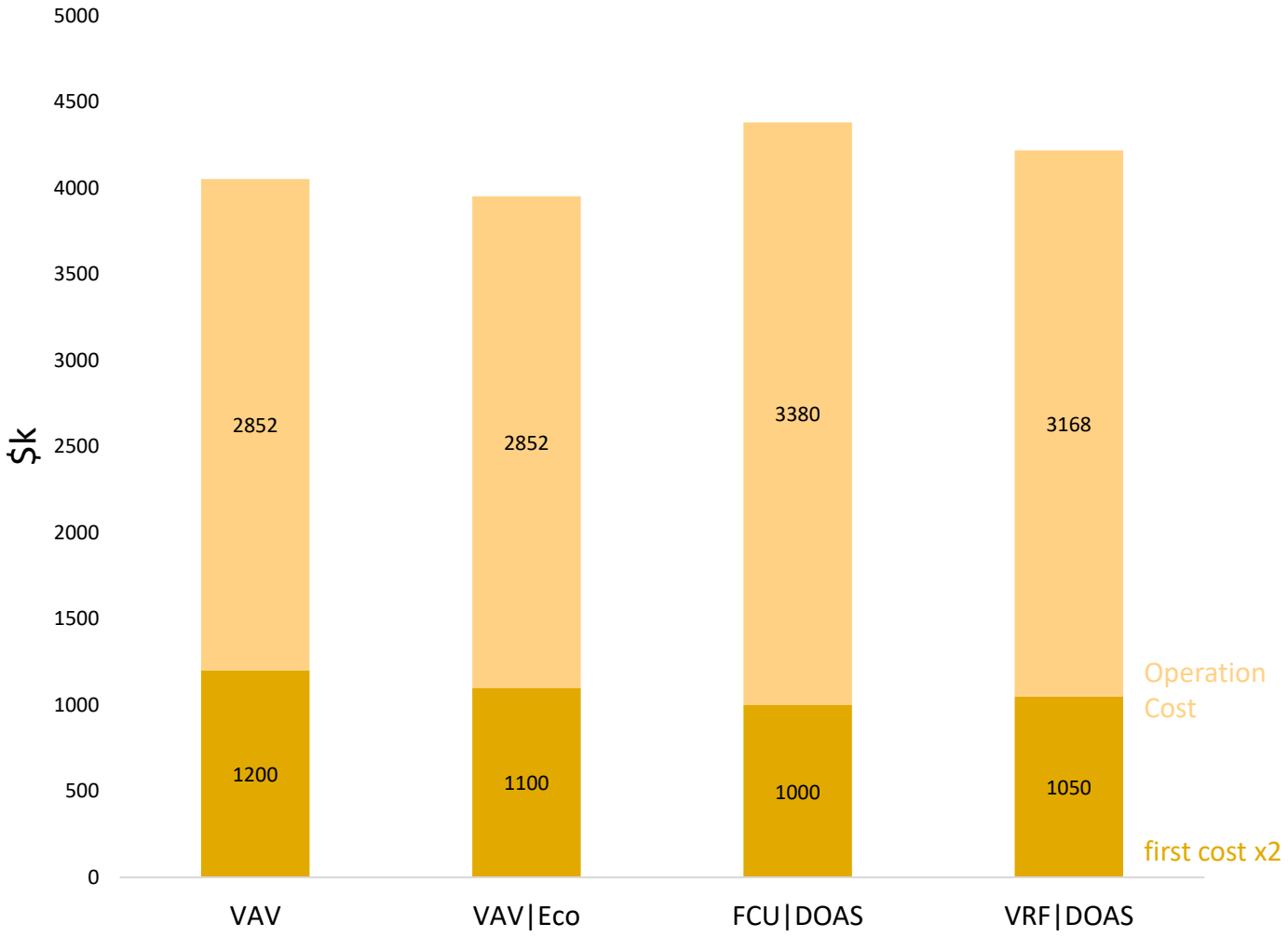
HVAC System Comparison



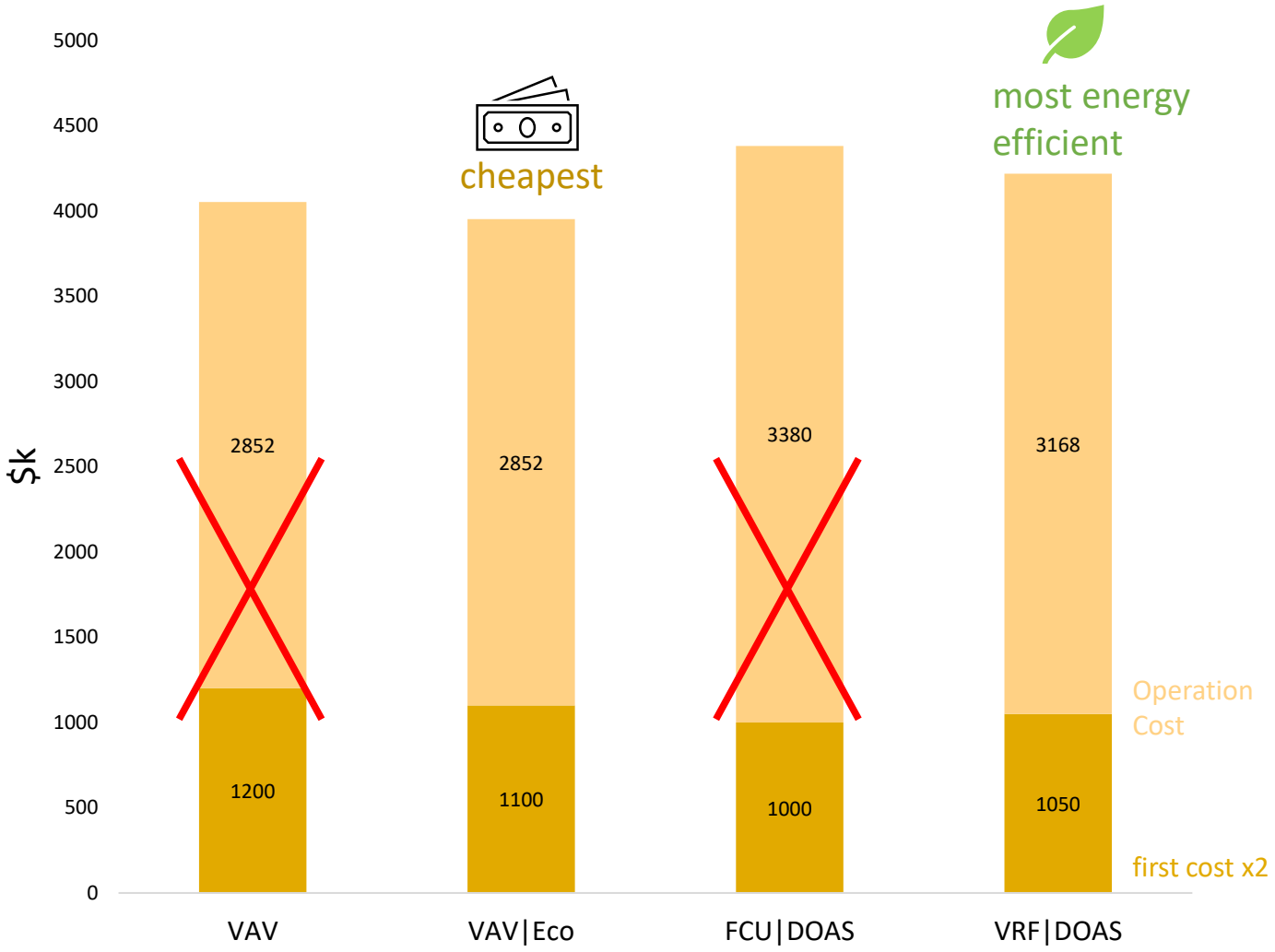
HVAC |EUI


- 3 %
- 8 %
- 15 %
Energy Use Intensity (kWh/sq.m)
60
50
40
30
20
10
0
VAV
VAV + Economizer
FCU + DOAS
VRF + DOAS
Heating
Cooling
Lighting
Equipment
Fan
Pump
Heat Rejection

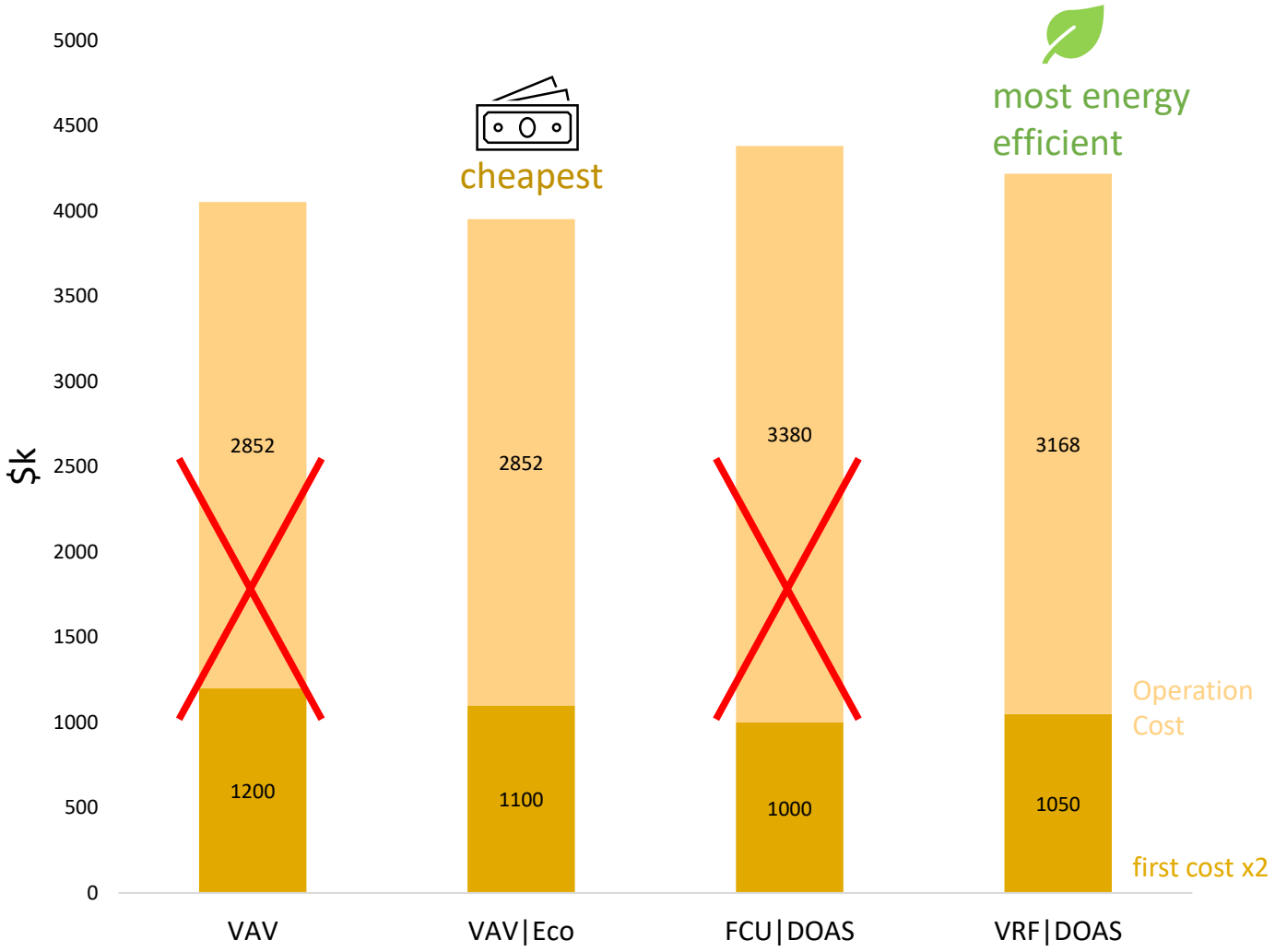
HVAC | Cost over 50 years



HVAC | Cost over 50 years



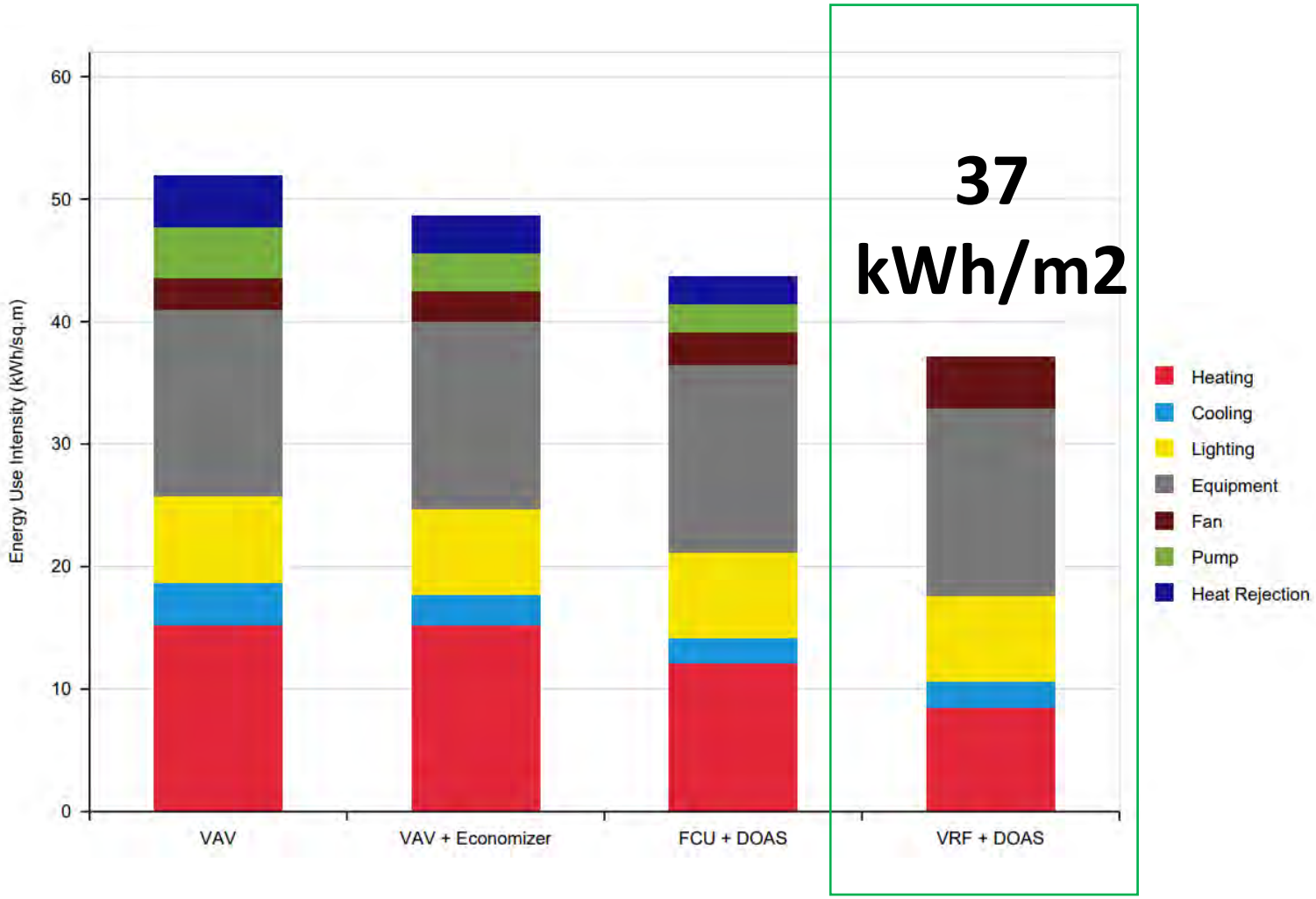
HVAC | Cost over 50 years



VRF|DOAS uses **20 times** less space than VAV|ECO

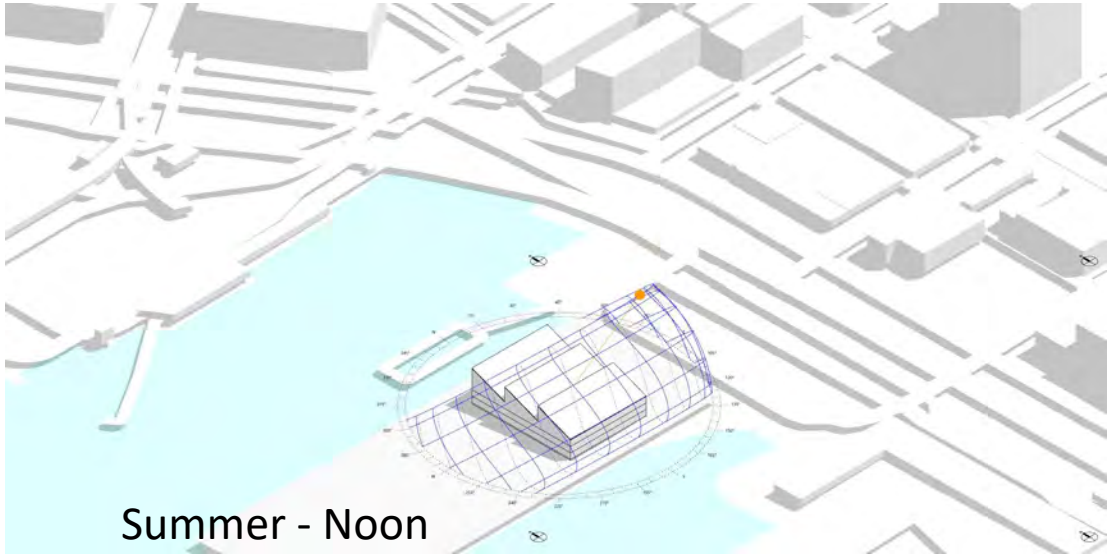
VRF|DOAS is implemented into the design

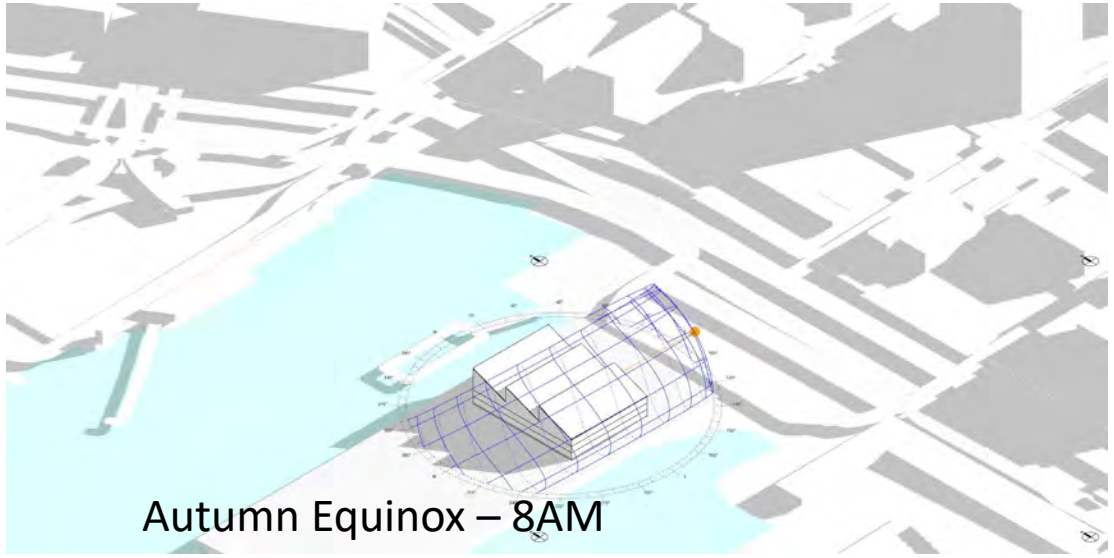
Final EUI

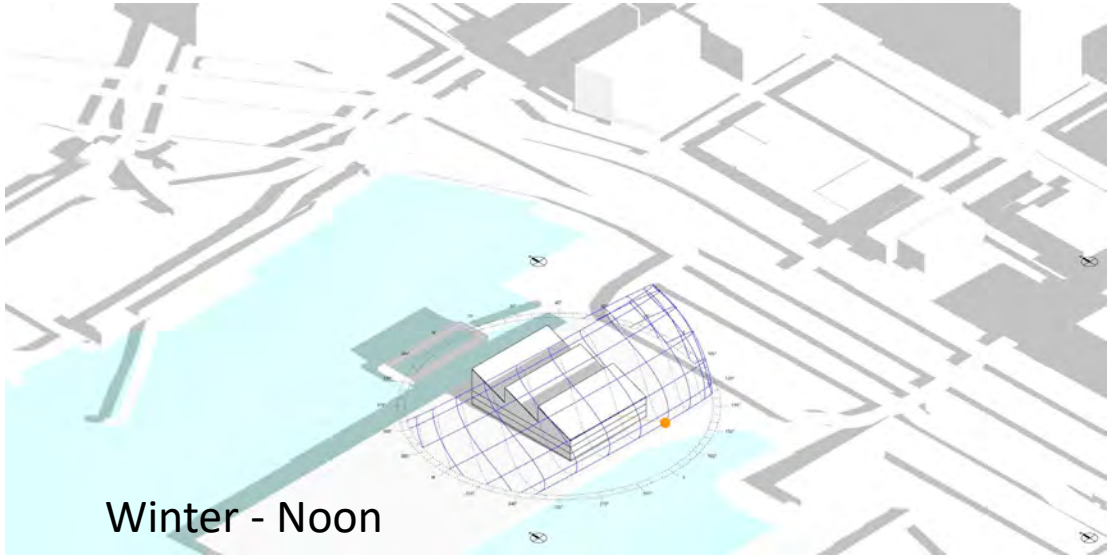


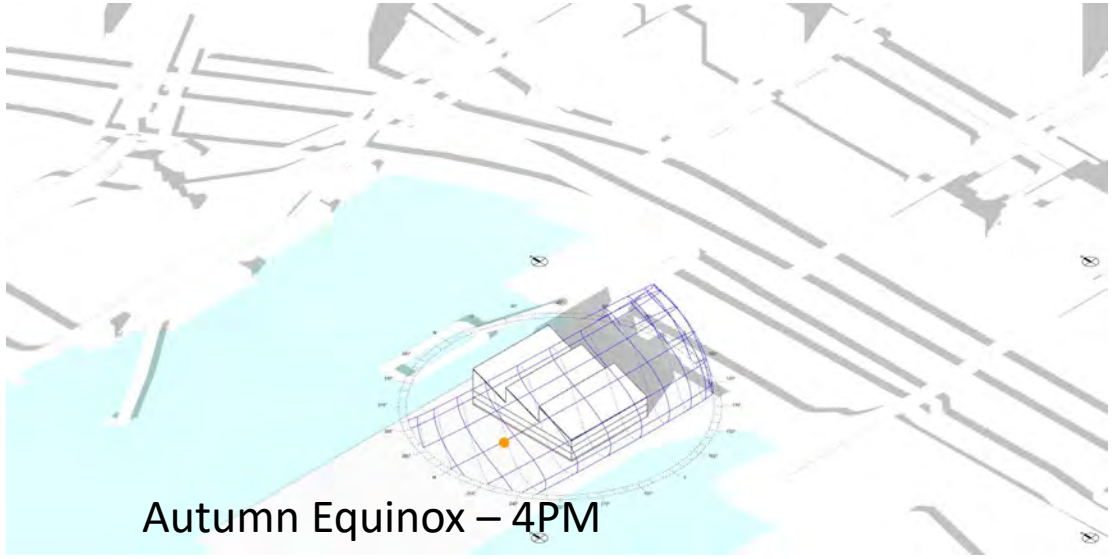
Target EUI: below 61 kWh/m2 (19.5 BTU/ft2)

Shading Study – PV Placement

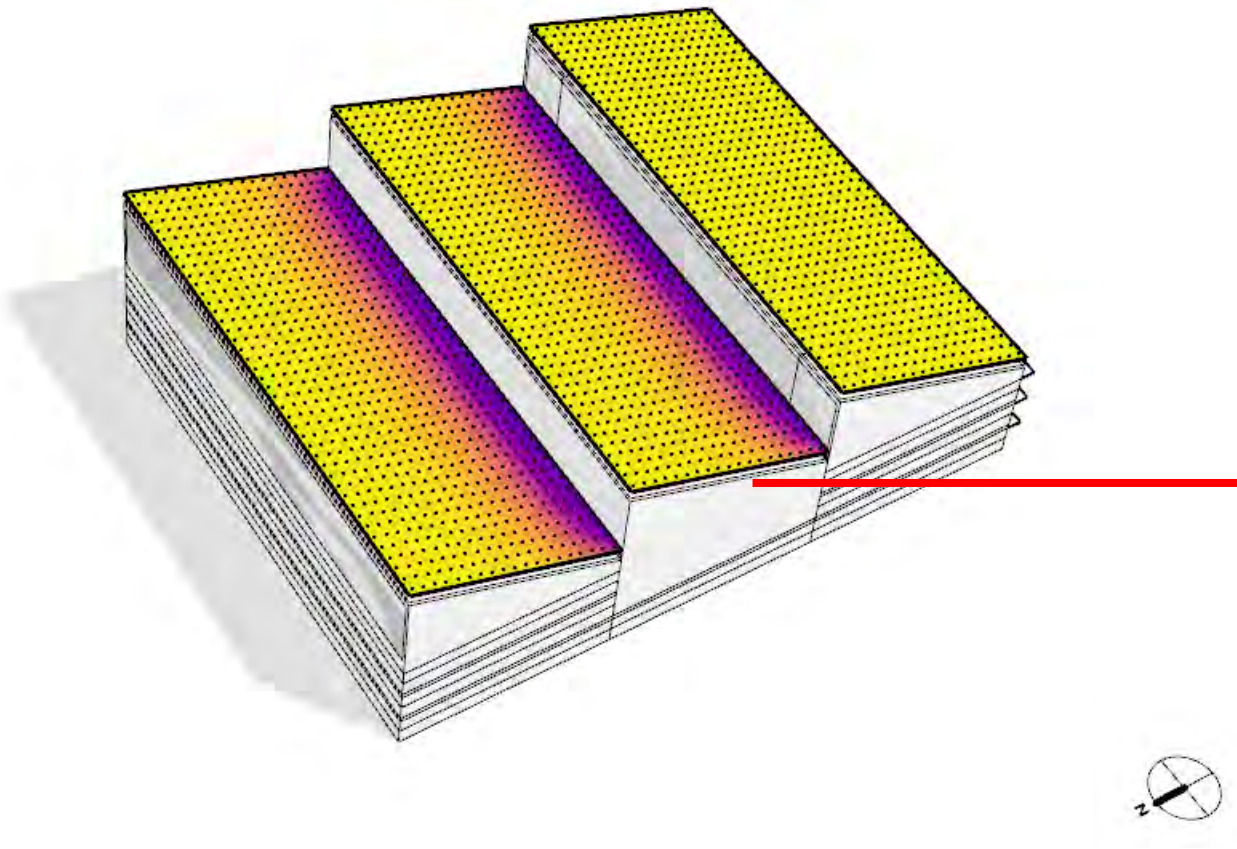






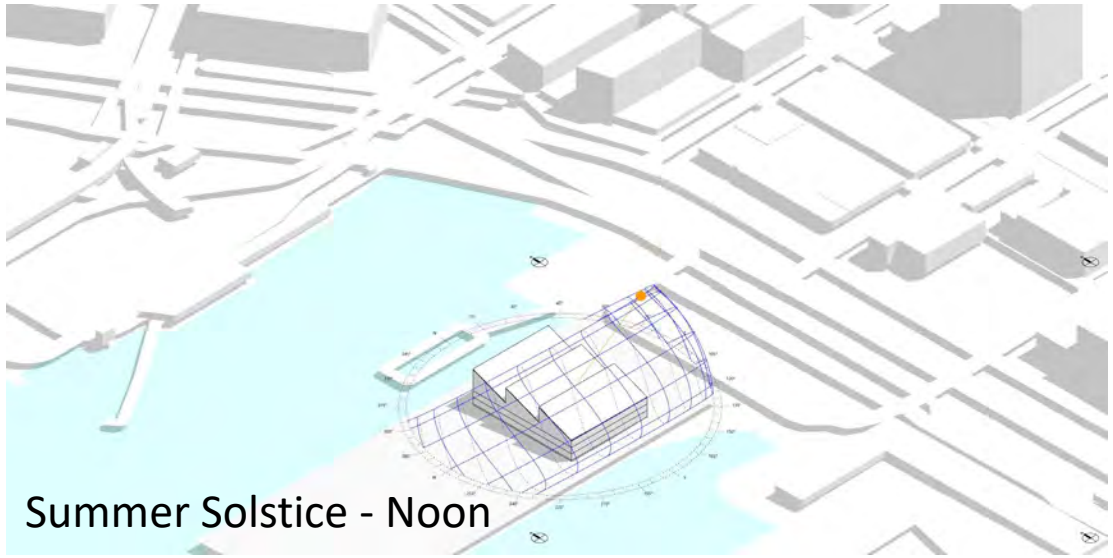


PV Placement – Self Shading



No PV in shaded area
(lower 3 m of roof)

PV Yield - Comparison



Initial massing

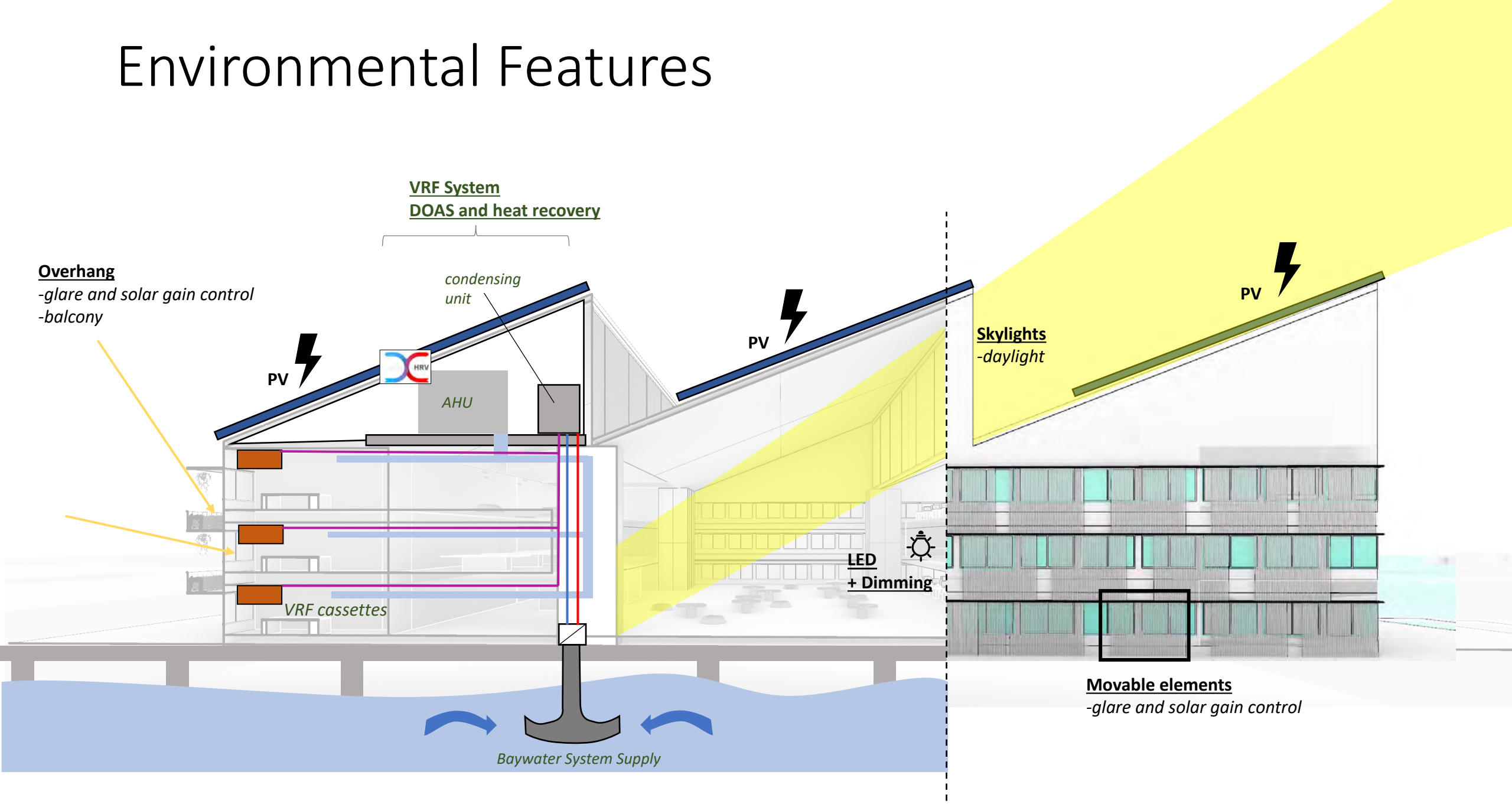
307,500 kWh annually

~ + 50 %

Final Design

459,035 kWh annually

Environmental Features



Concluding Thoughts

Conclusions

Minimize unoccupied hours

- Amenity space open to the public

Maximize occupancy comfort

- Individualized control of shading and glare protection elements
- Recreational spaces
- Skylight and atrium daylight concept
- Atrium, meeting spaces and balconies encourage collaboration

Achieve low EUI by responding to the climate

- Roof Concept - Skylights + PV
- Baywater as water loop for condensing unit of VRF