



Nakagin 2.0: Parameterizing the metabolist dream

Sam Wolk
Nikita Klimenko

料金所 400m
TOLL GATE

Nakagin Capsule Hotel

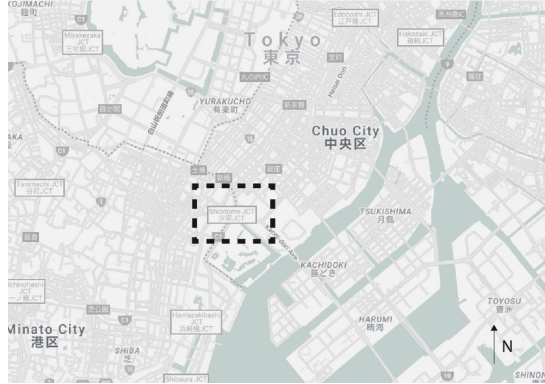
Cubicles optimized to individual preferences

Design Goals

- Metabolist design spirit
- Offices of various sizes
- Efficient use of narrow site
- Customizable floor plan

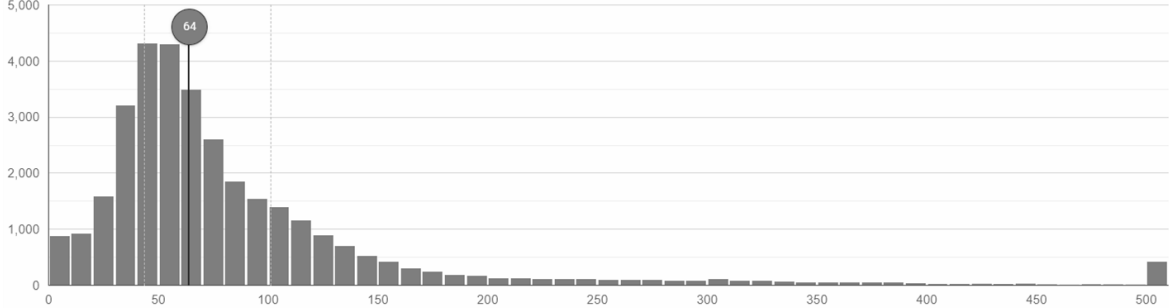


Site Plan and Context



Target EUI

median = 64 KBtu/sq.ft = 202 KWh/sq.m

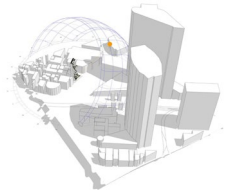


Site EUI (kBtu/ft²)

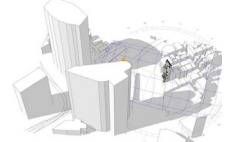
	2010 (Vol. 2)		2011 (Vol. 3)	
	Number of properties	EUI (kWh/m².a)	Number of properties	EUI (kWh/m².a)
New York	15	271	31	275
London	125	427	165	398
Tokyo	5	293	21	190

Source: Greenprint Performance Reports.

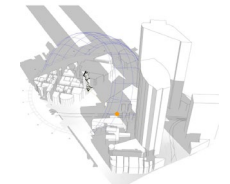
Shading Study



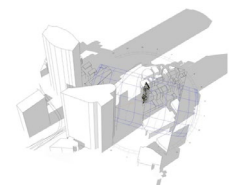
August, 23, 13:21



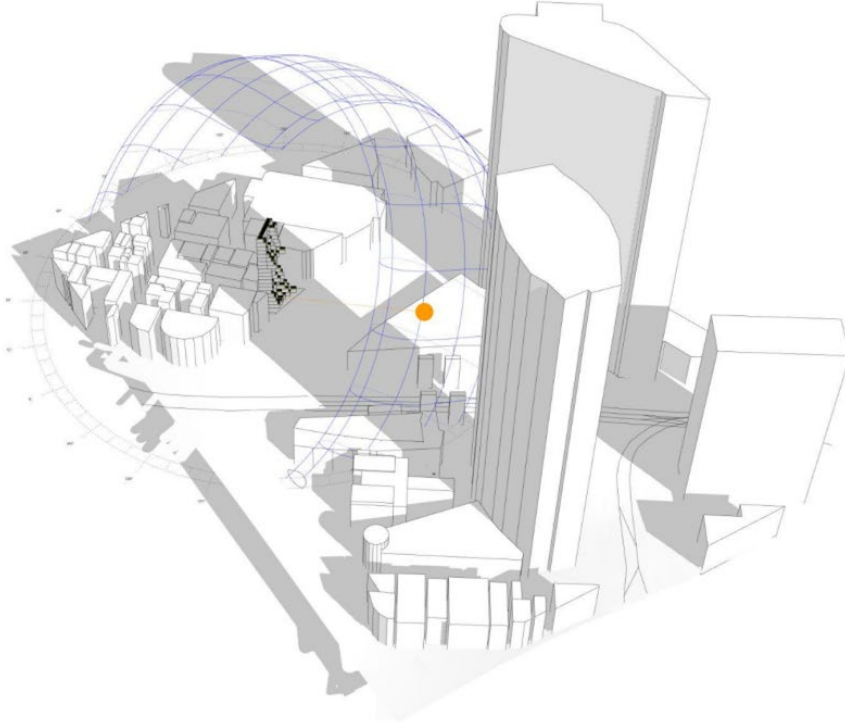
April, 11, 13:58



August, 23, 16:58

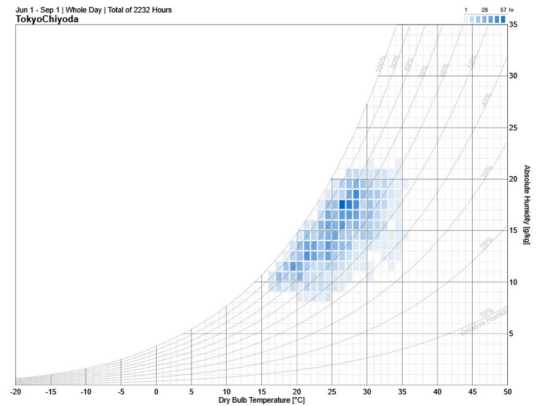


November, 17, 13:58

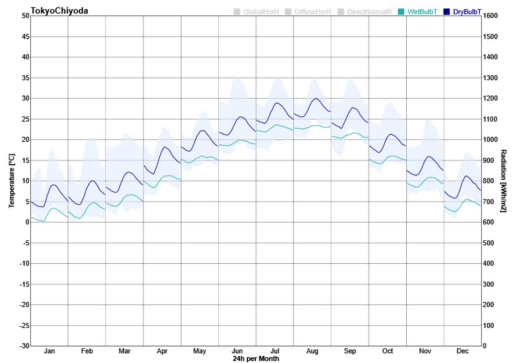


August, 23, 15:39

Climate



Psychrometric chart, Tokyo (Zone 4A Mixed hot and humid)



Diurnal dry bulb variation, Tokyo

Precedents



tiNY by SO_IL, New York

narrow site, well-lit



Habitat 67 by Moshe Safdie, Montreal

adaptable, diverse spaces



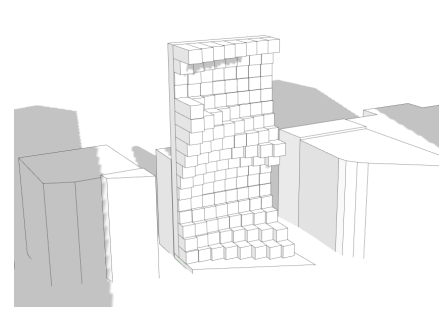
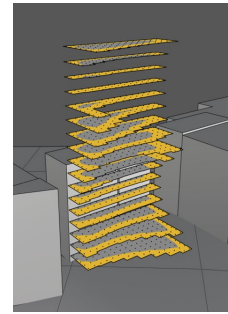
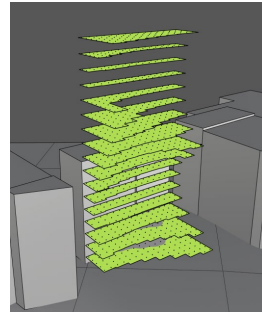
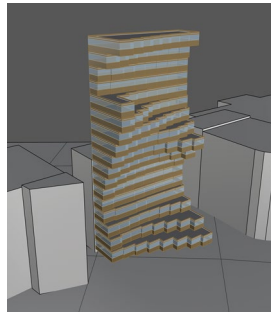
Ting 1 by Agrob Buchtal, Örnköldsvik, Sweden

facade with extrusions

Massing models

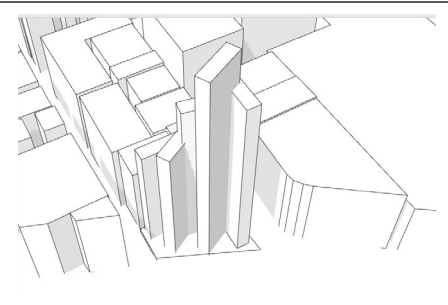
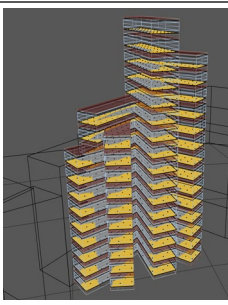
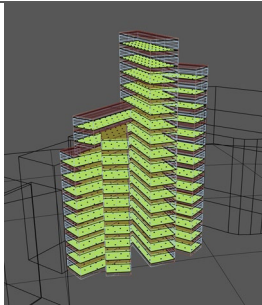
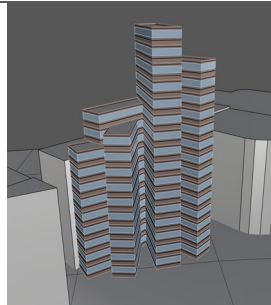
Metabolic

Customizable office space
Overhang space for PV
Faces major light direction



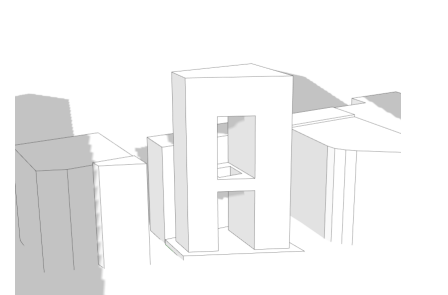
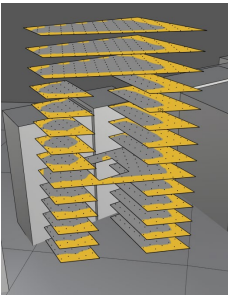
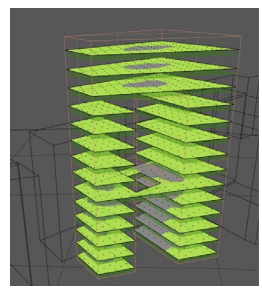
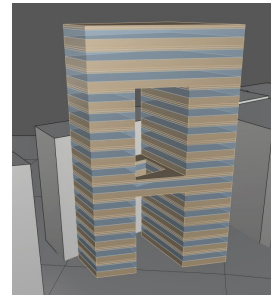
Star-shaped

Diverse views
Better window space



A-Shaped

Shaded courtyard
Shaded courtyard



Massing

Daylight

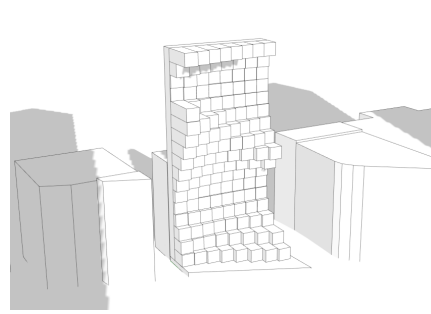
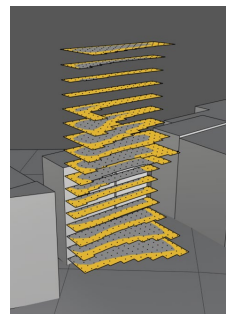
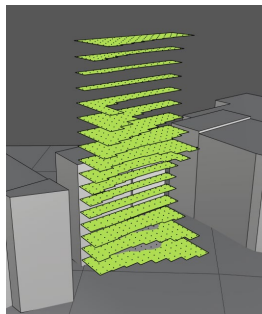
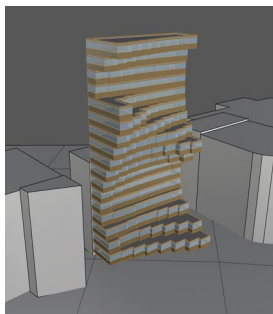
Glare

Daylight views, Noon, Jan 1

Massing models

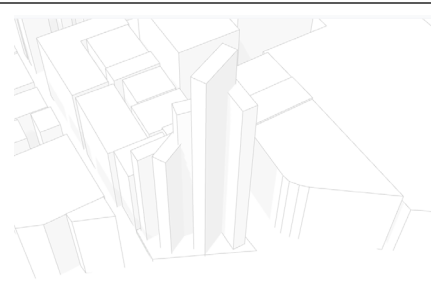
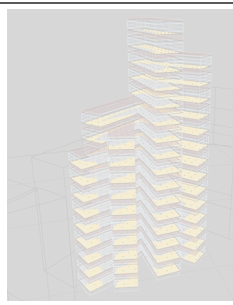
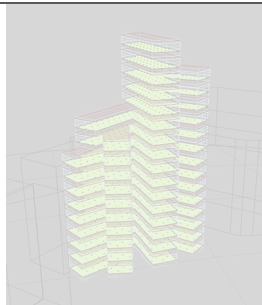
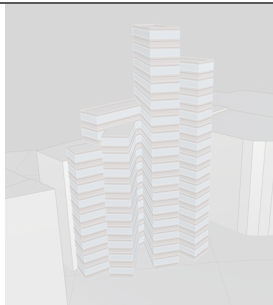
Metabolic

Customizable office space
Overhang space for PV
Faces major light direction



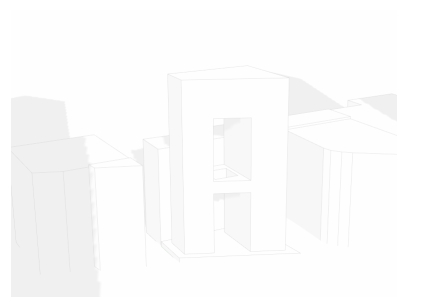
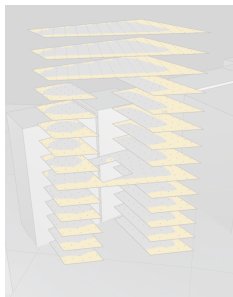
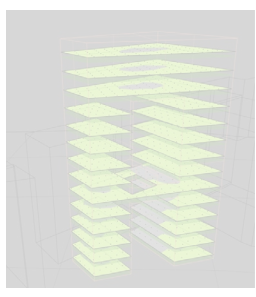
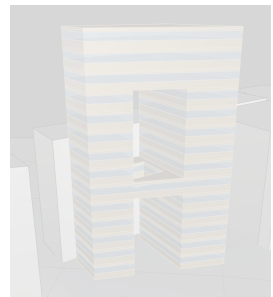
Star-shaped

Diverse views
Better window space



A-Shaped

Shaded courtyard
Shaded courtyard



Massing

Daylight

Glare

Daylight views, Noon, Jan 1

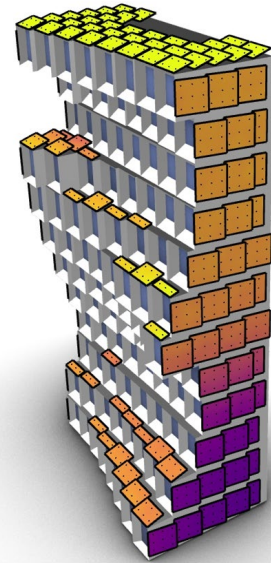


PV: Architectural Setbacks Increase PV Area

- 1m x 1.5m cells
- 1003.5m² of PV coverage (669 cells)
- Mean Radiation: 911kWh/m²
- 18% efficiency factor

EUI Offset: 55.7kWh/m²

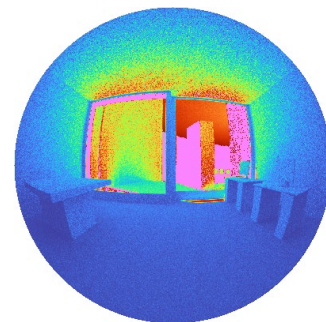
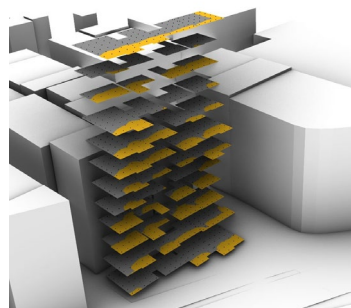
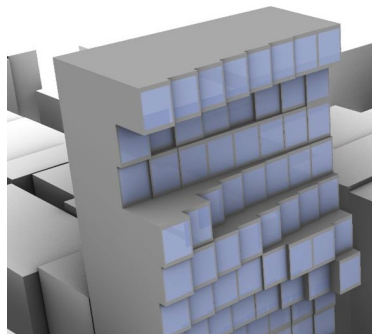
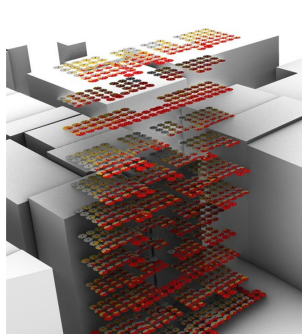
17.3 kBtu/ft²



Daylight and glare

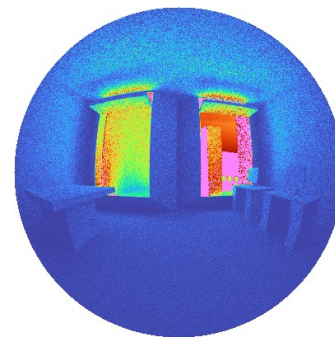
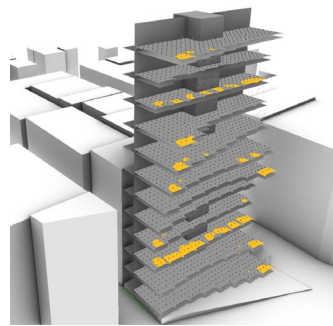
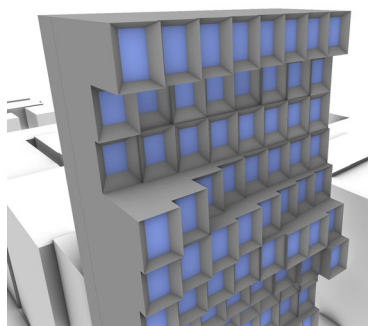
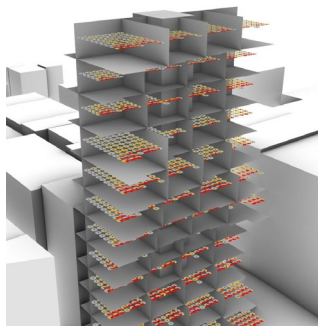
constant high WWR
no overhangs

$sDA_{300} = 93\%$
 $ASE_{1000,250} = 25\%$
 $sDG_{5\%} = 34.4\%$



light shelf
slanted overhangs
parametric WWR

$sDA_{300} = 91.2\%$
 $ASE_{1000,250} = 9.8\%$
 $sDG_5 = 8.5\%$



Glare analysis

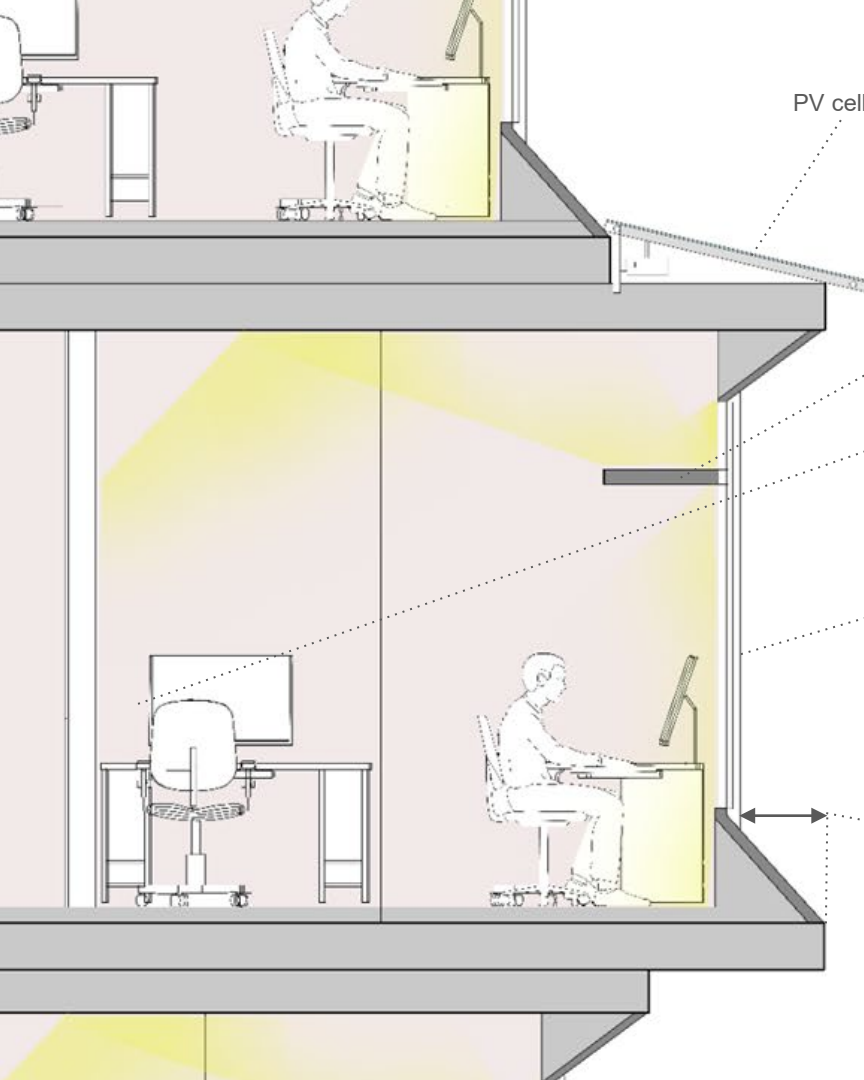
Massing

ASE analysis



Glare rendering

Light Facade Design

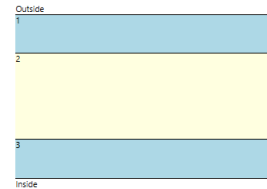


PV cell

light shelf helps propagate more light into the room

Slanted overhangs prevent direct light rays

adapted glazing solution

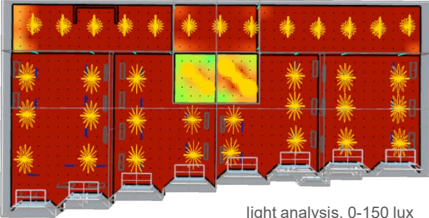


extruded parametrically based on the unit's protrusion factor and incident sunlight/shade

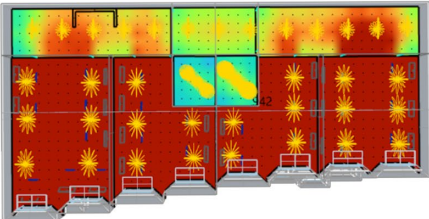
Electric lighting



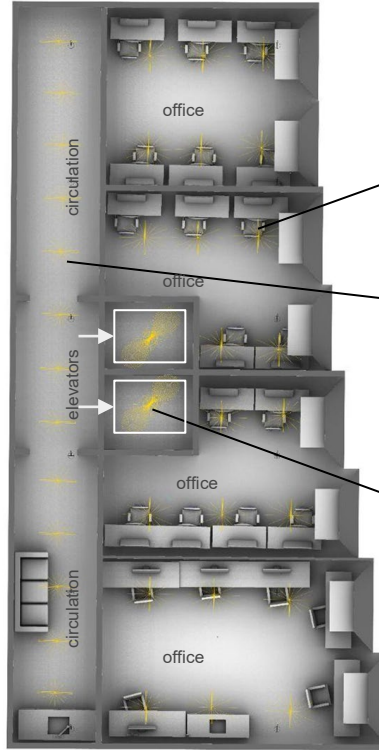
light analysis, 0-100 lux
(Elevator benchmark)



light analysis, 0-150 lux
(Corridors benchmark)



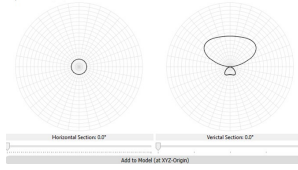
light analysis, 0-300 lux
(Corridors benchmark)



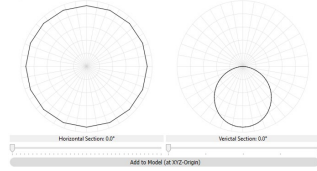
Sample Floorplan



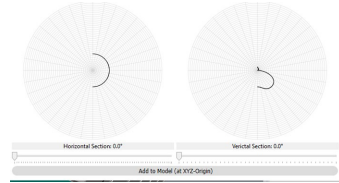
Chopstick suspended, MesoOptics Lens, 6500lm/4ft, 80 CRI, 3000K,7505LCAQN04



MicroSquare gen2 surface, Silk Lens/Solid Housing, 1300lm/4ft, 80 CRI, 3000K 2211LCKLN



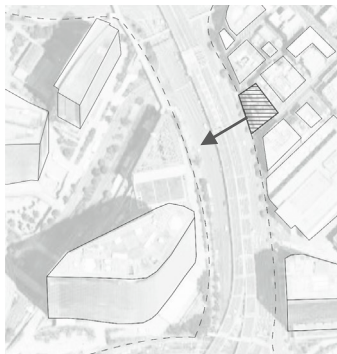
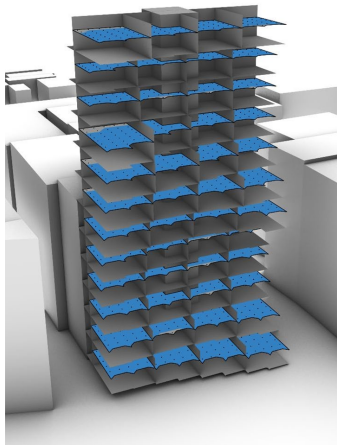
SoftView Garage SVPG, A01 configuration, 80CRI 3000K, Type 1R optic SVPG-A01-830-T1R



List of lights used



View analysis



unobstructed view onto highway
+ towers

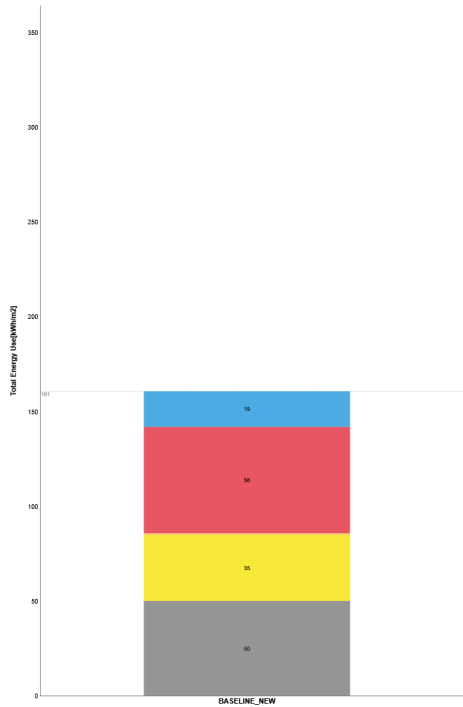


interior view

Views

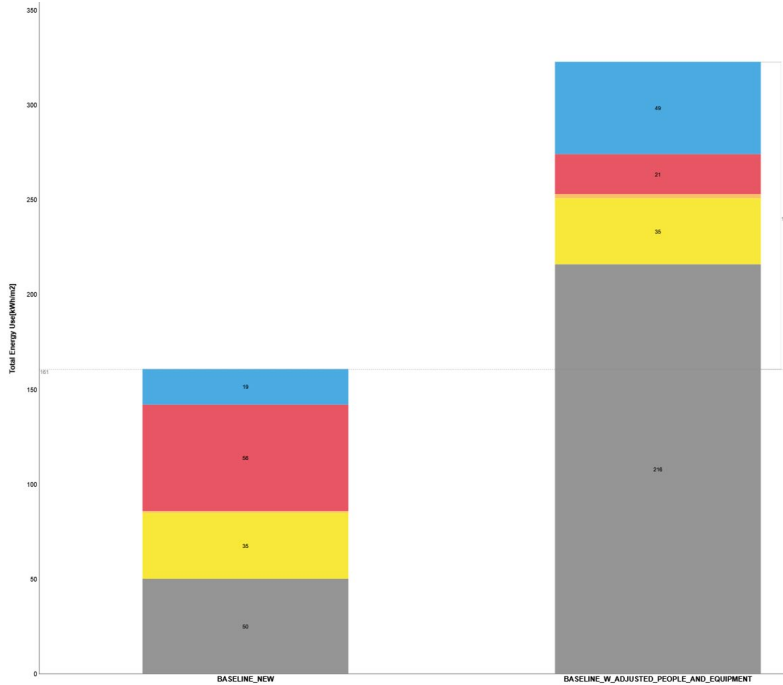


EUI: Adjusting for Equipment and Occupancy



EUI before upgrades/adjustments:
161kWh/m² or 49.9 kBtu/ft²

EUI: Adjusting for Equipment and Occupancy



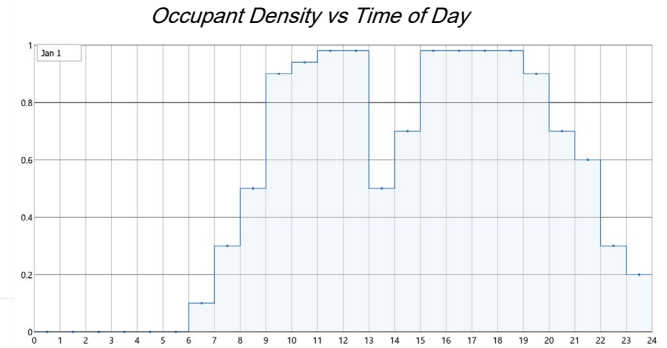
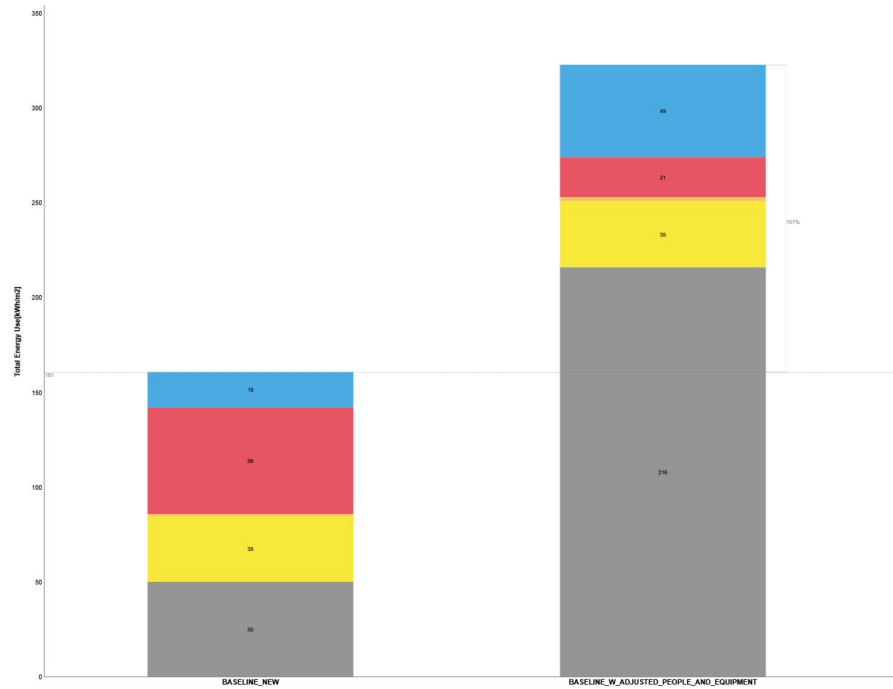
Dense Tech Startup Offices:

45.52 W/m² (peak equipment load)

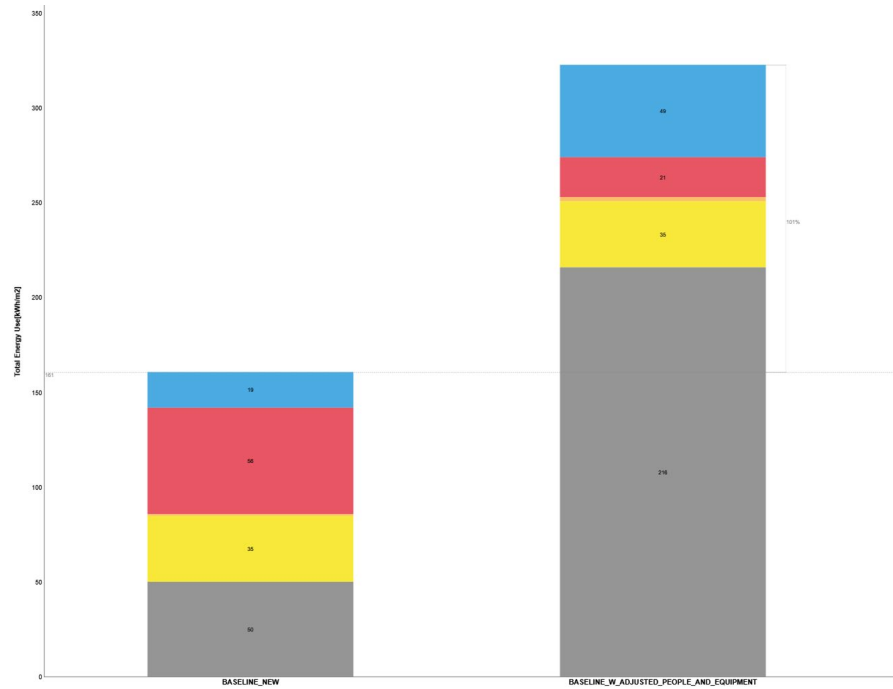
0.139 occupants/m² (density)

327W/occupant (peak load)

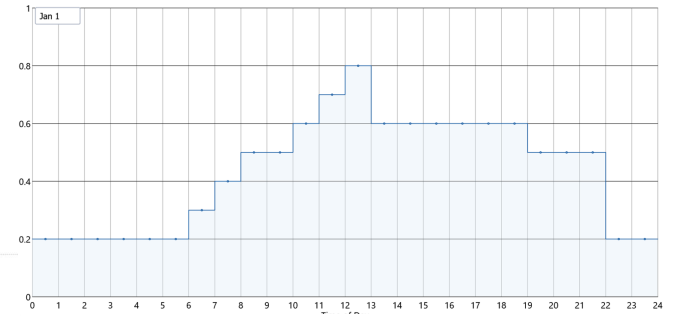
EUI: Adjusting for Equipment and Occupancy



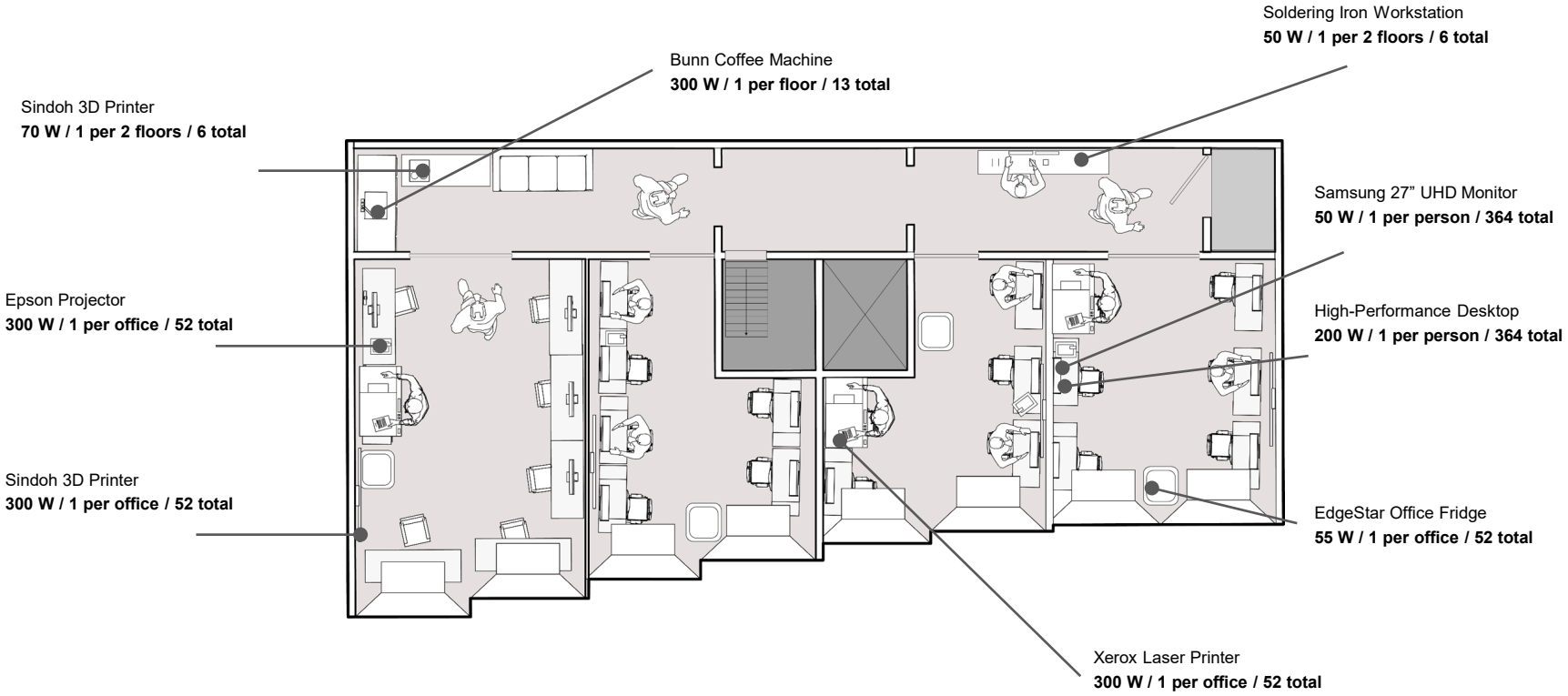
EUI: Adjusting for Equipment and Occupancy



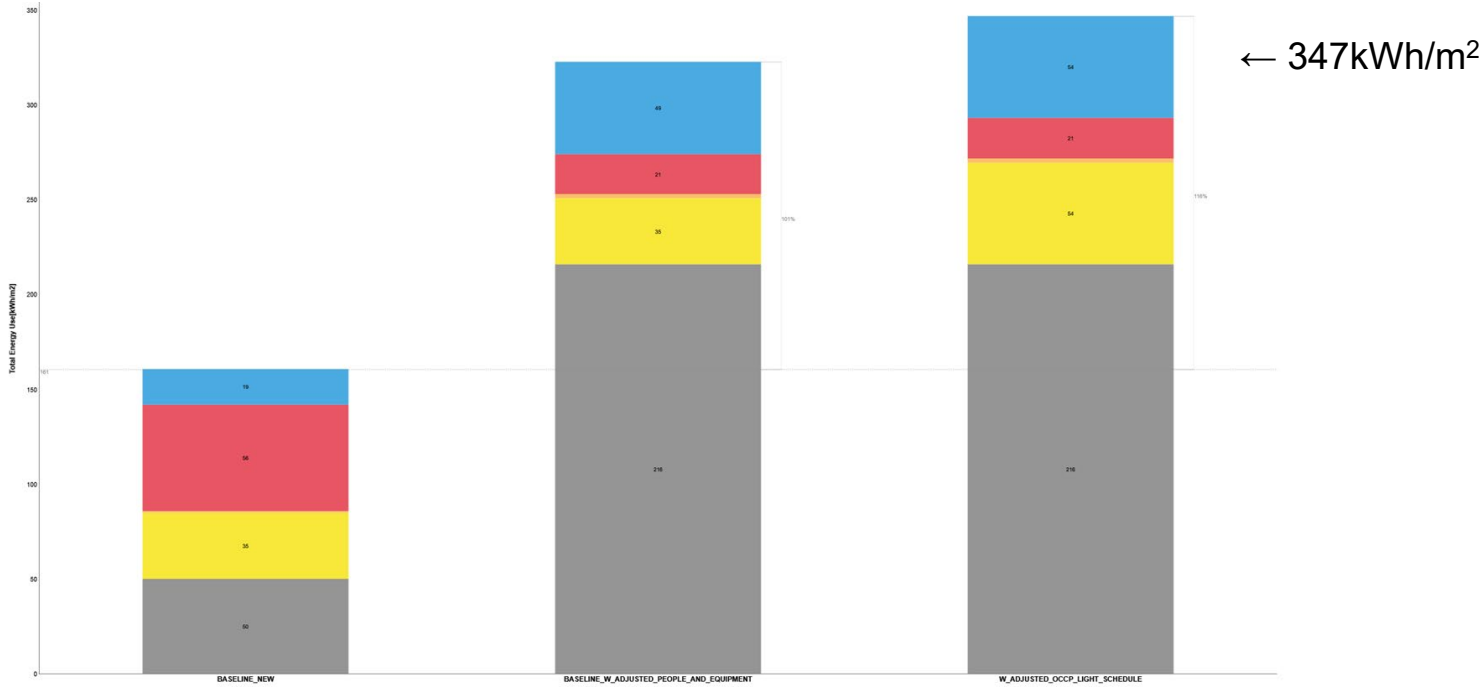
Percentage of Peak Equipment Load vs Time of Day



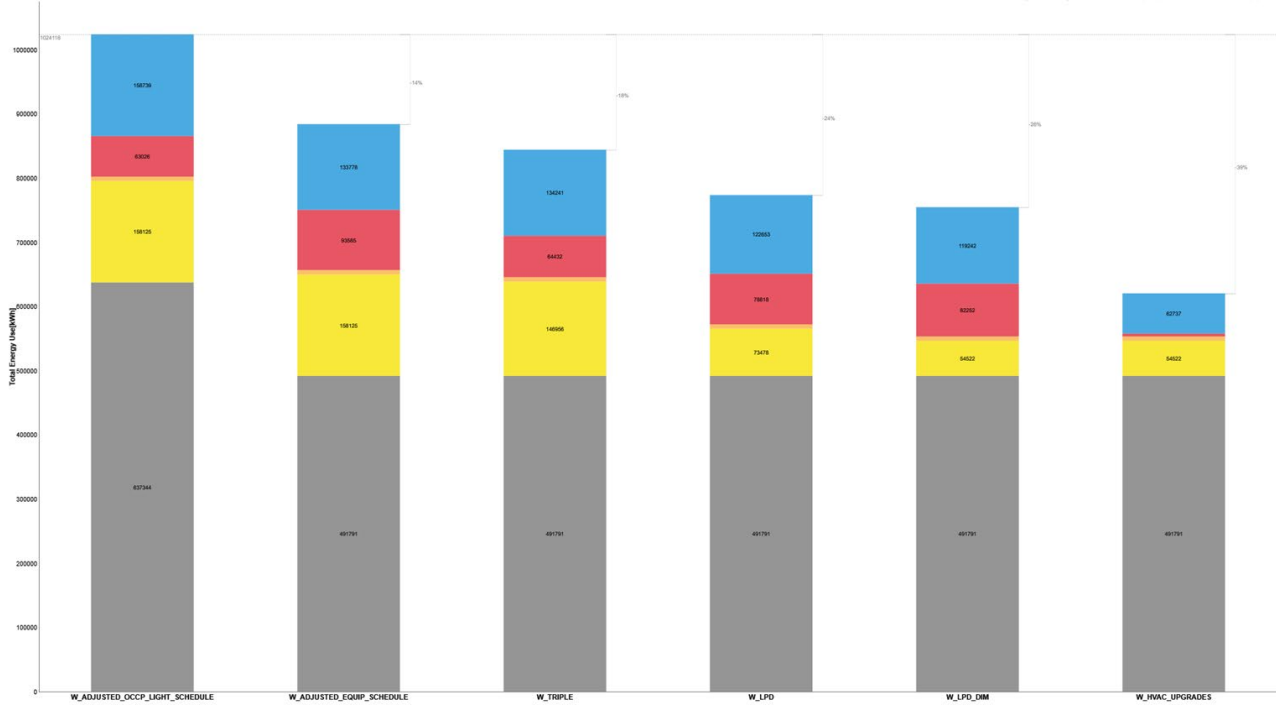
EUI: Adjusting for Equipment and Occupancy



EUI: Adjusting for Equipment and Occupancy



EUI: Upgrades Path

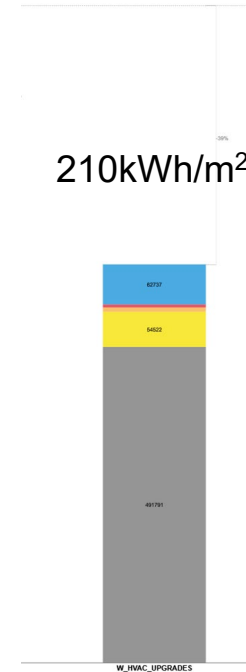
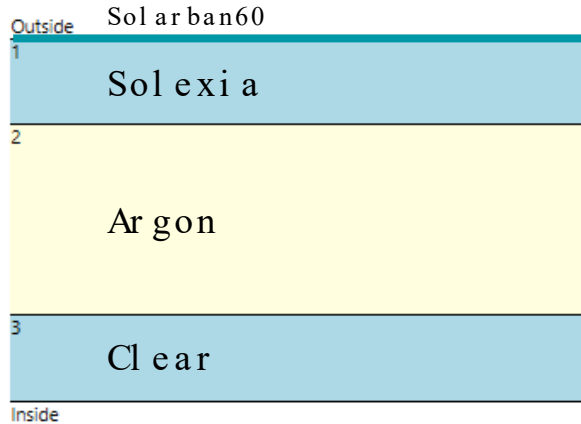


Baseline > Schedules > Envelope > LPD > Dim > HVAC

EUI: Upgrades Path

Envelope: Glazing

- Double Paned (Solexia outer/Clear inner)
- Argon gas intermediary
- Solarban 60 outer coating
- U-value: $1.36 \text{ W m}^2 \text{ K}^{-1}$
- SHGC: 0.31
- Tvis: 60%



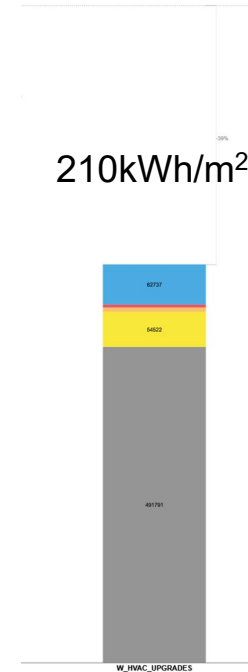
EUI: Upgrades Path

HVAC: Hot and Humid Climate

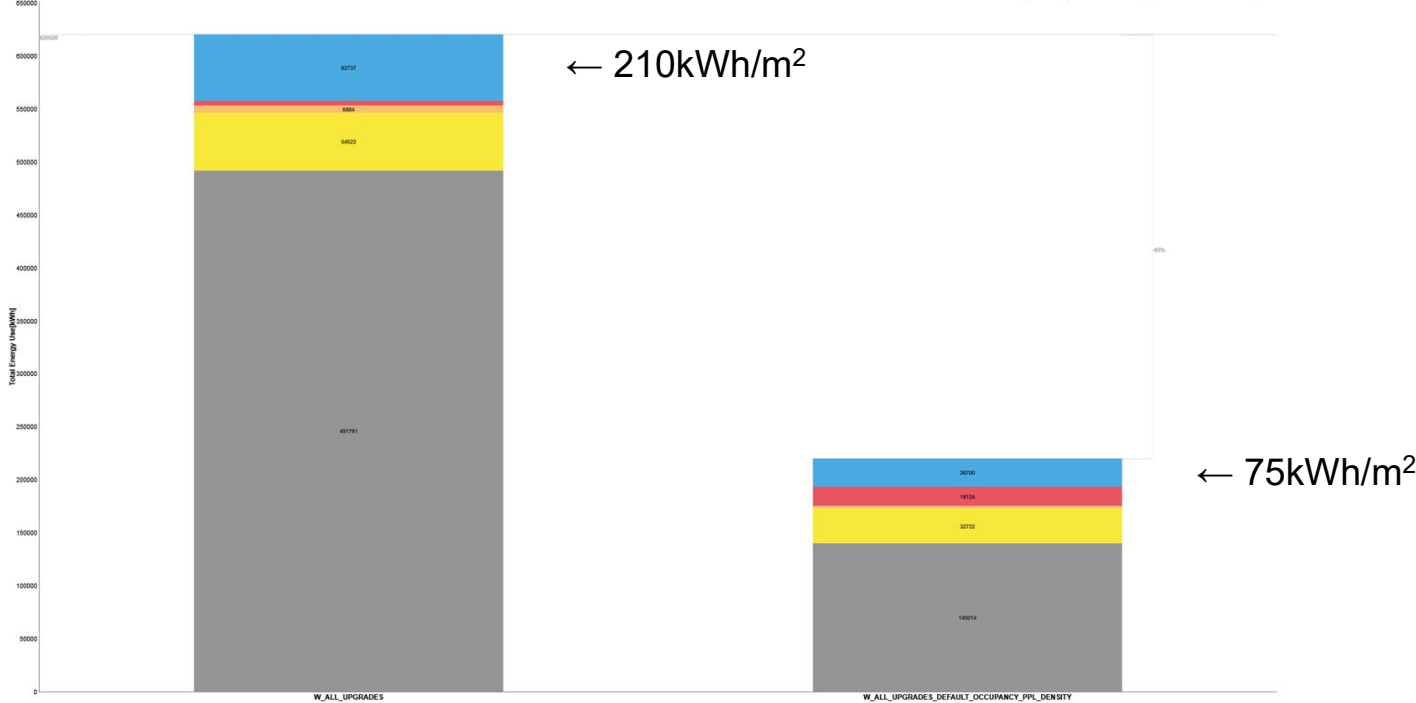
- Enthalpy HRV: 0.9 sensible and 0.75 latent recovery
- Differential Enthalpy Economizer
- GSHP: COP=4.0
- Occupied Set Points: 19.5 (heating) / 24.3C (cooling)
- Unoccupied Set Points: 15.2C (heating) / 26.5C (cooling)
- Fresh Air: 20L/s/person

Lighting:

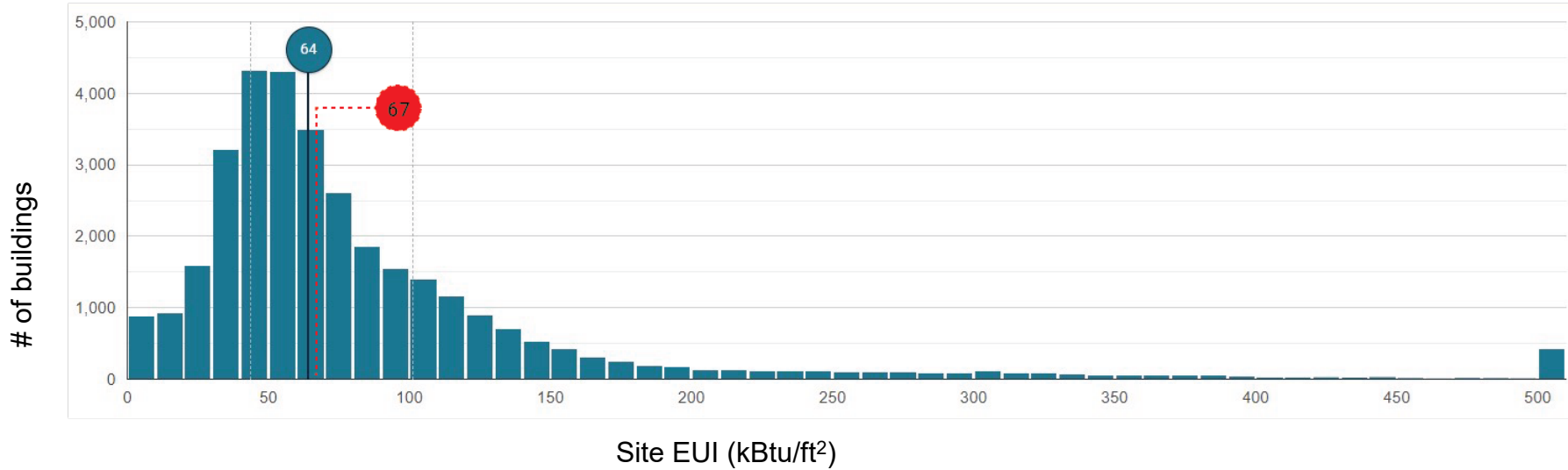
- 5W m² LPD
- 350lux target illuminance (all occupants close to windows and sky, so lower value chosen)



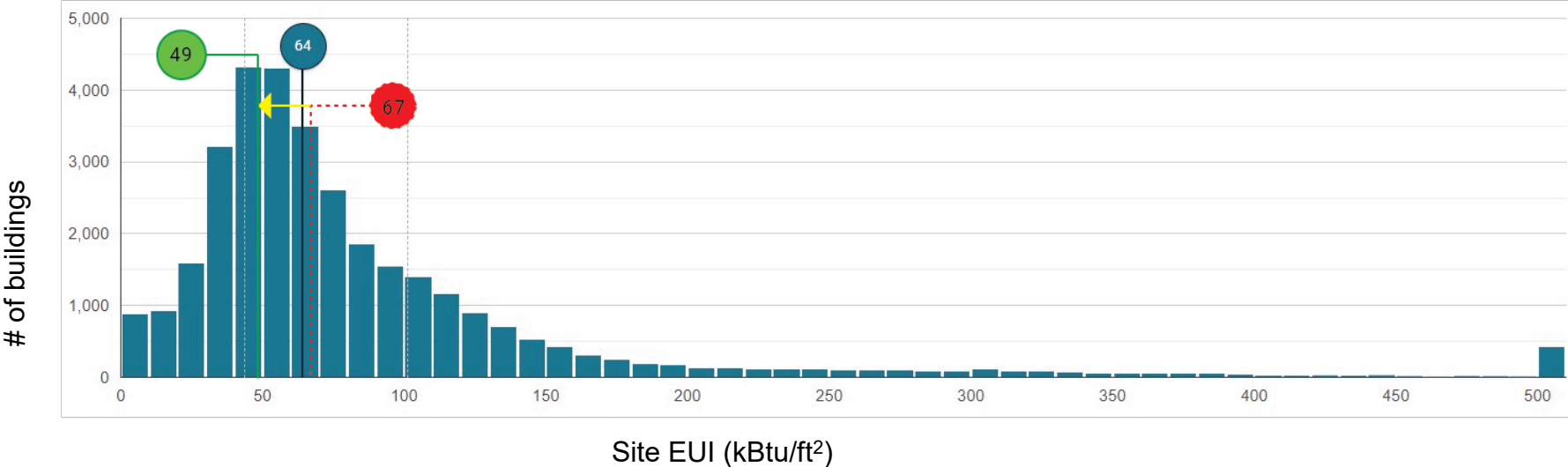
EUI: True Occupancy/Equipment vs Default



Comparison to EUI Distribution / Benchmark



Comparison to EUI Distribution / Benchmark



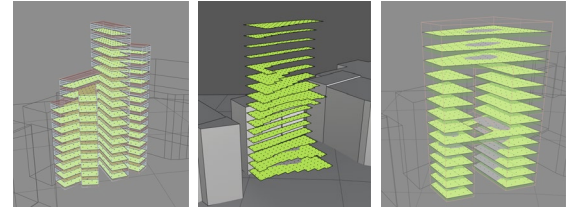
Concluding thoughts

EUI Benchmarks carry bias based on equipment and density, site specificity

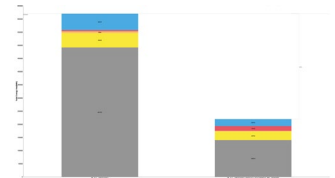
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London	125	427	165	398
Tokyo	5	293	21	190

Source: Greenprint Performance Reports.

Certain design decisions override optimization algorithms - the choice of extruded cubicles was more driven by concept and basic preferences for a certain view rather than careful optimization



People density and equipment loads significantly affect EUI,



Basic design strategies bring more returns than optimizations

