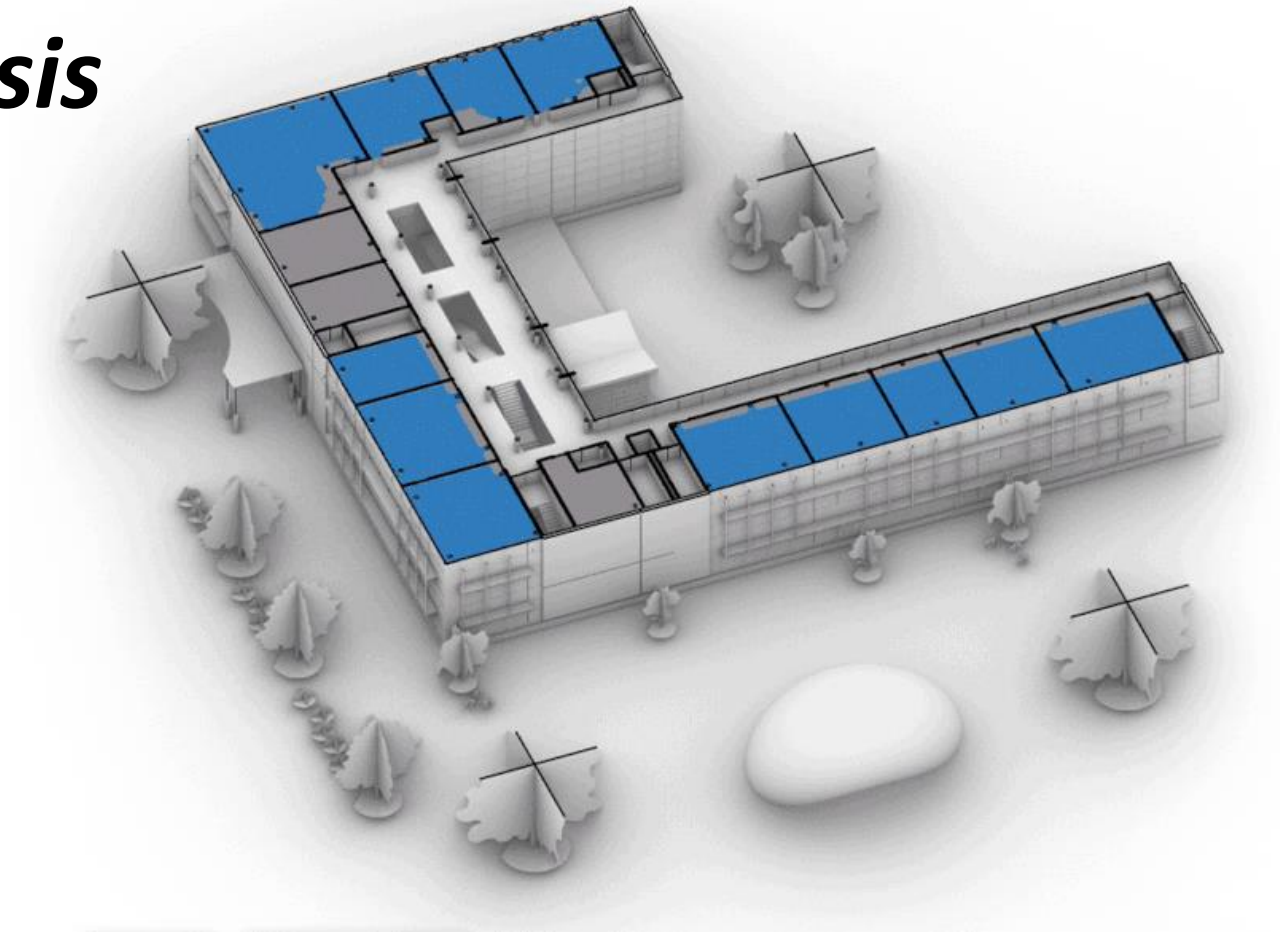
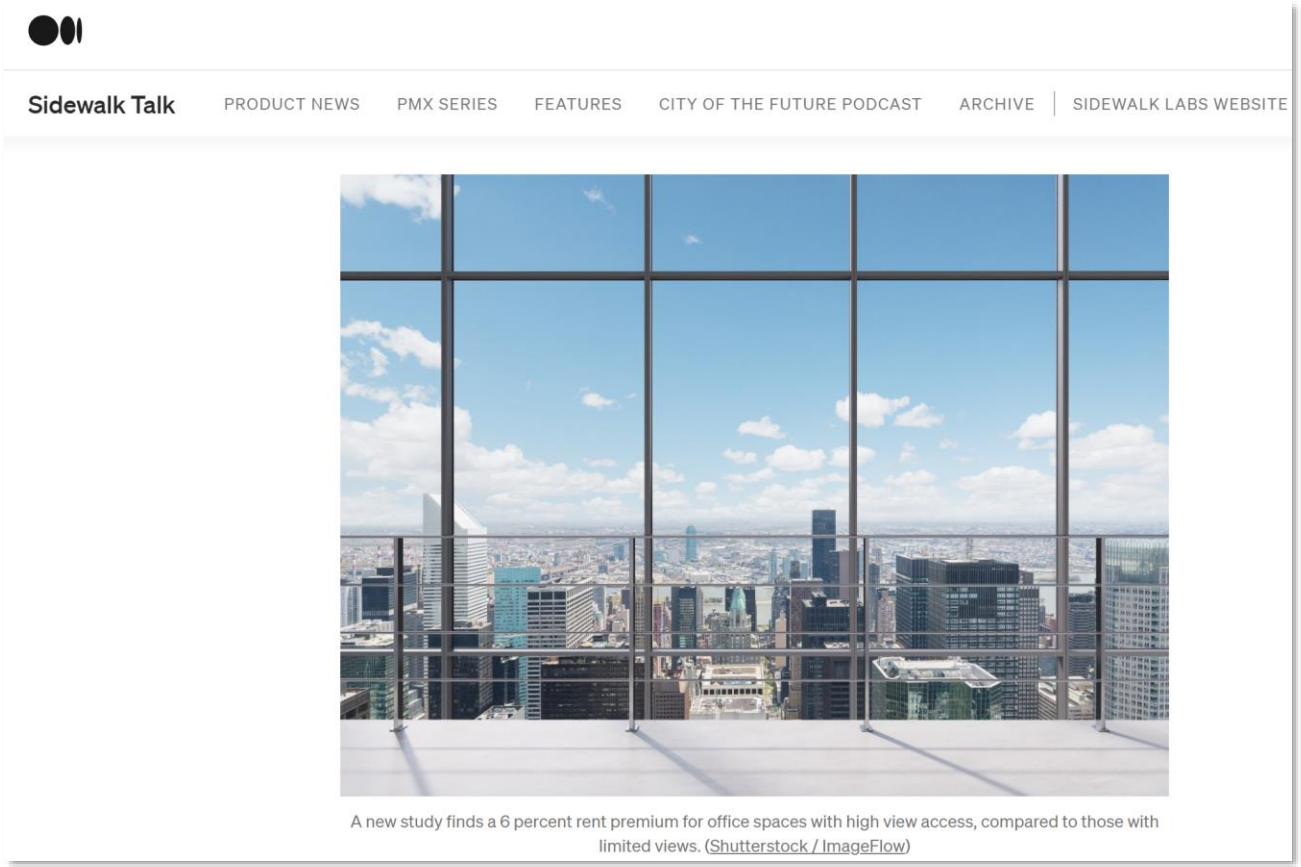
Simulation-based View Analysis



Christoph Reinhart, Jon Sargent (Solemma), Irmak Turan (IIT), Nada Tarkhan (MIT)

CBE Symposium on Window Views, Oct 13 2021

MIT SUSTAINABLE DESIGN LAB SOLEMMA

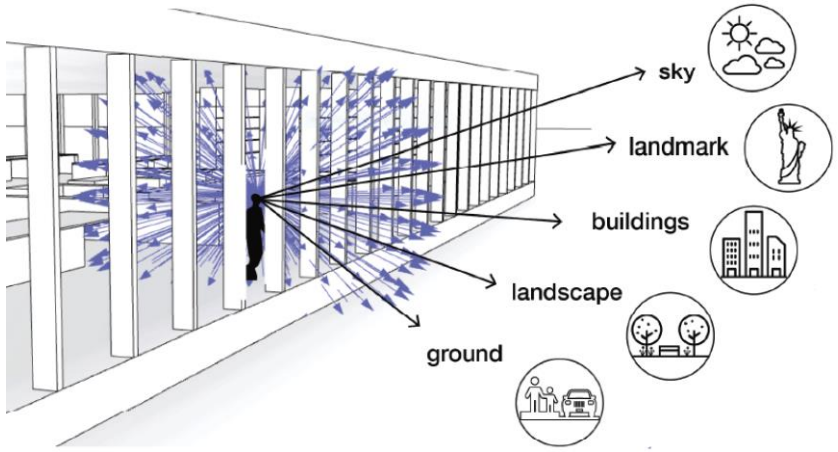


- A view is a universally recognized asset for building occupants, architects and real estate. However, each group different outlook/motivation to pursue view. Metrics might help to clarify what may constitute a good view.
- According to the symposium organizers: “the design industry lacks a holistic evaluation method of assessing the many qualities of a window view (e.g., content, accessibility, clarity)”
- So, what do we know and what is missing?

Figure: https://medium.com/sidewalk-talk/the-view-from-your-office-window-whats-it-worth-97dc01189d52

Computational Design Approaches to View

Content



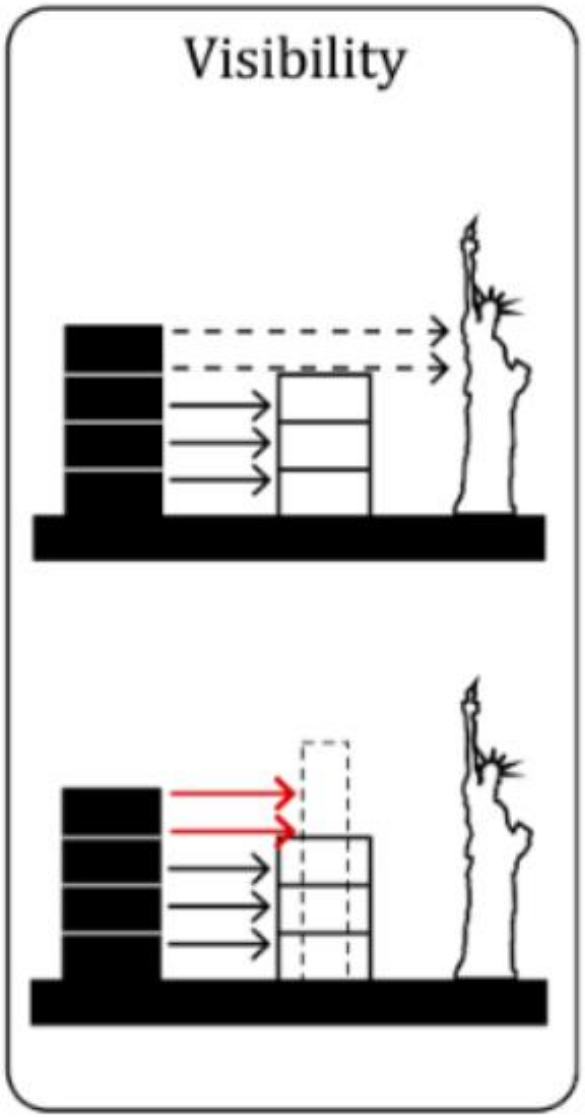
- Objects of interest are tagged
- Content is analyzed at discrete viewpoints via raytracing

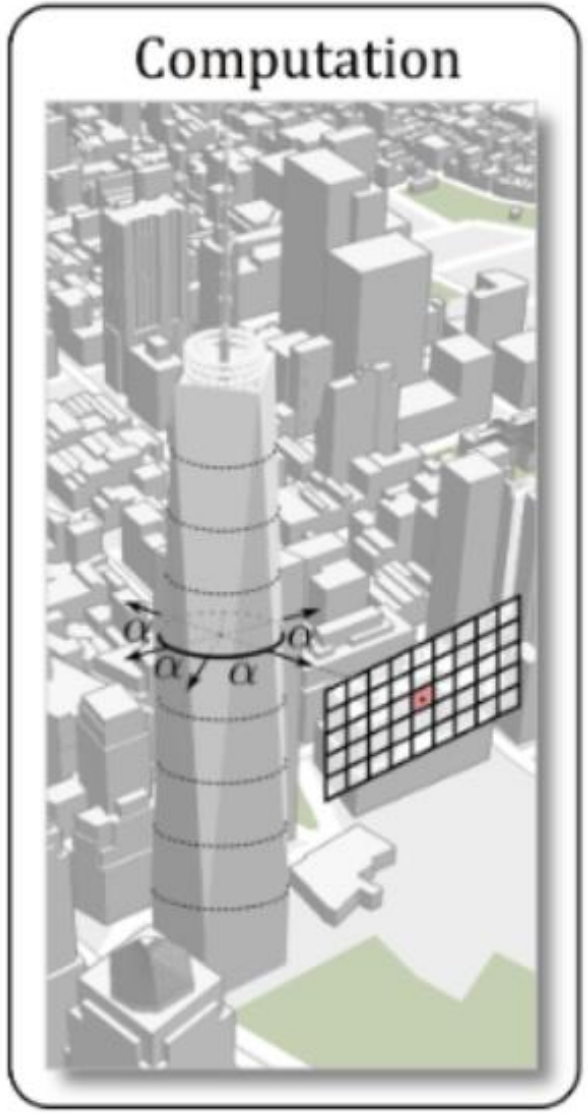
Figure: I. Turan

Accessibility

Clarity

View as a Formgiver

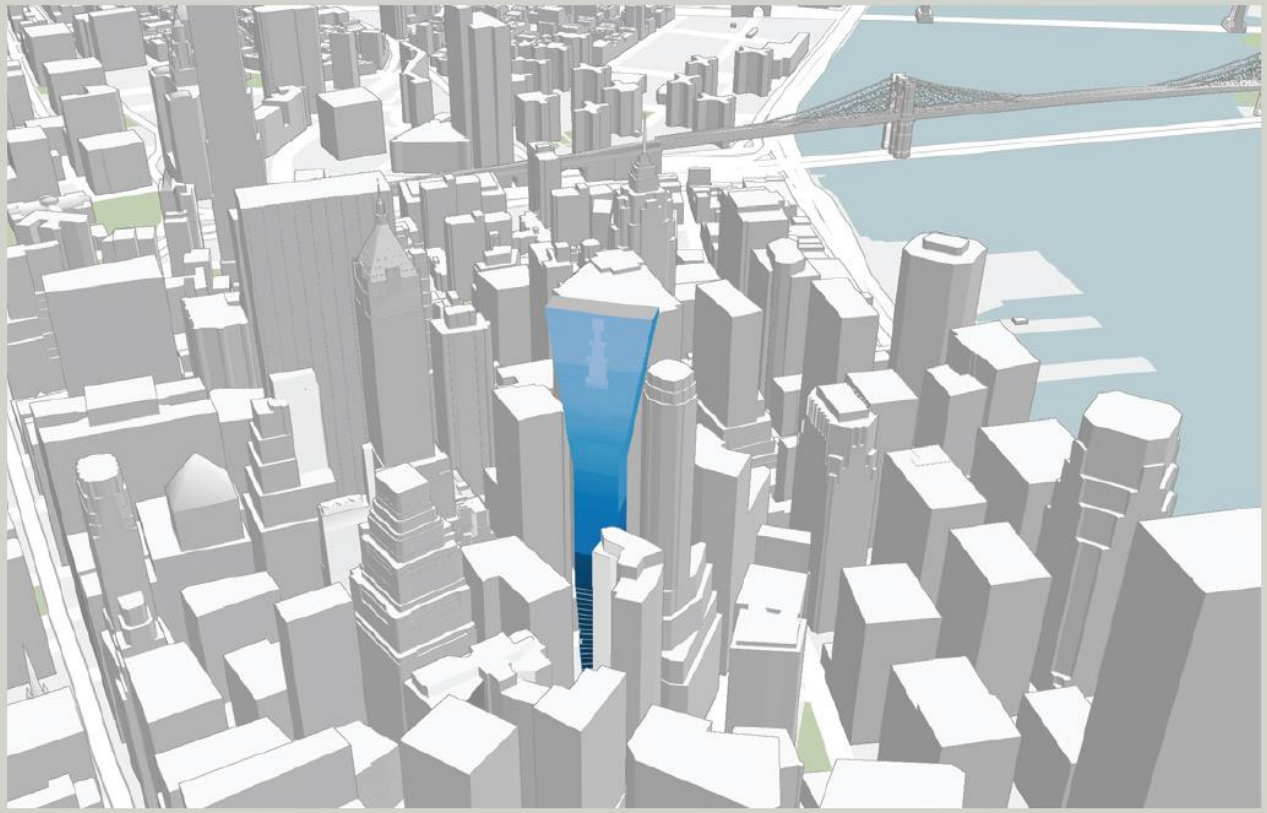




H. Doraiswamy, N. Ferreira, M. Lage, H. T. Vo, L. Wilson, H. Werner, M. Park and C. Silva, “Topology-based Catalogue Exploration Framework for Identifying View-Enhanced Tower Designs,“ ACM Transactions on Graphics , Proceedings of Siggraph Asia 2015, 34:6, pp. 230–247

View as a Formgiver

Urban view analysis of a skyscraper design in Manhattan



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A LEED Quality View meets the following two criteria:

Type 2: Can see 2 of 3 through vision glass:

- *Nature / Art / Urban landmarks*
- *Objects > 25 ft.*

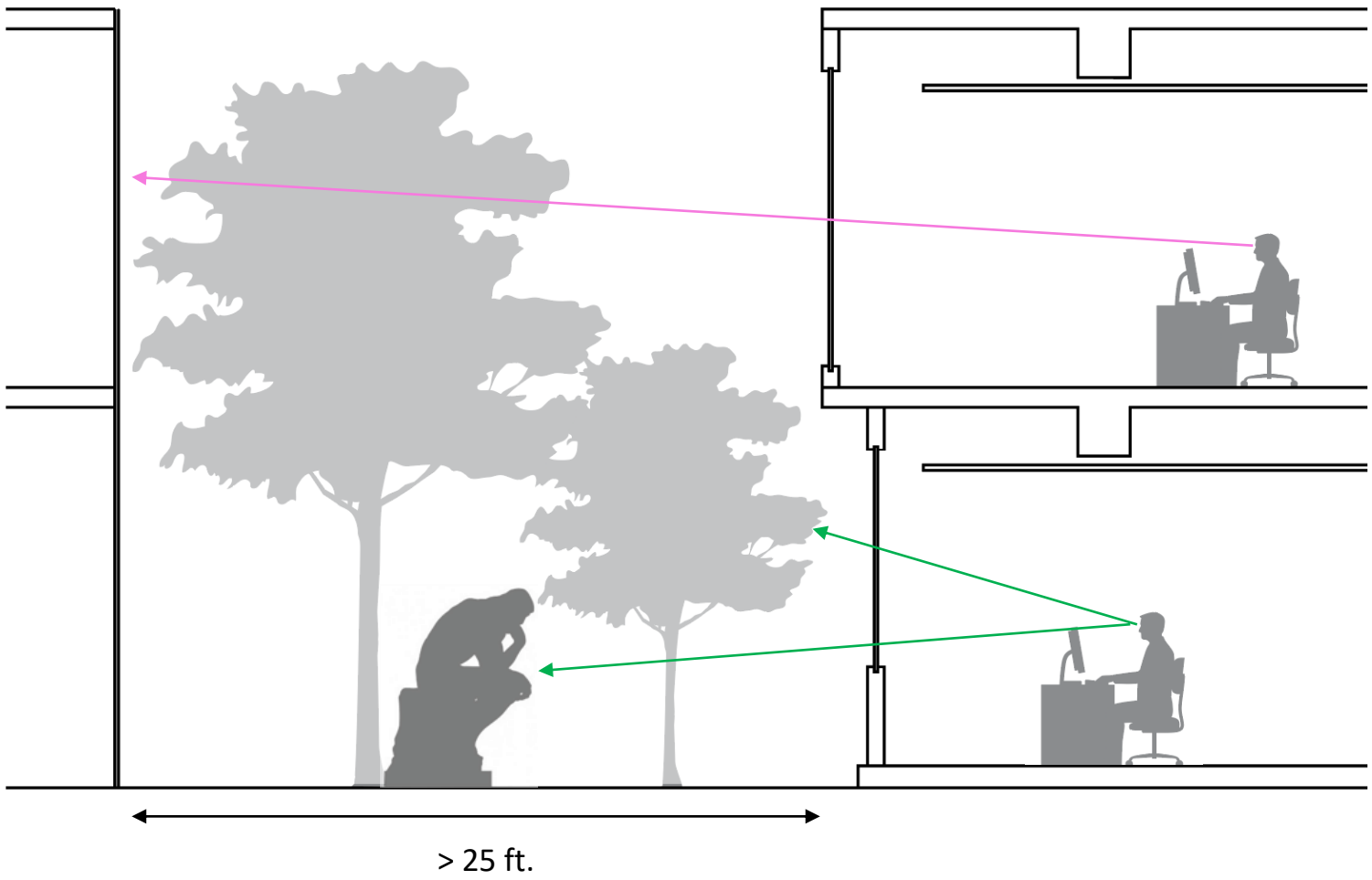


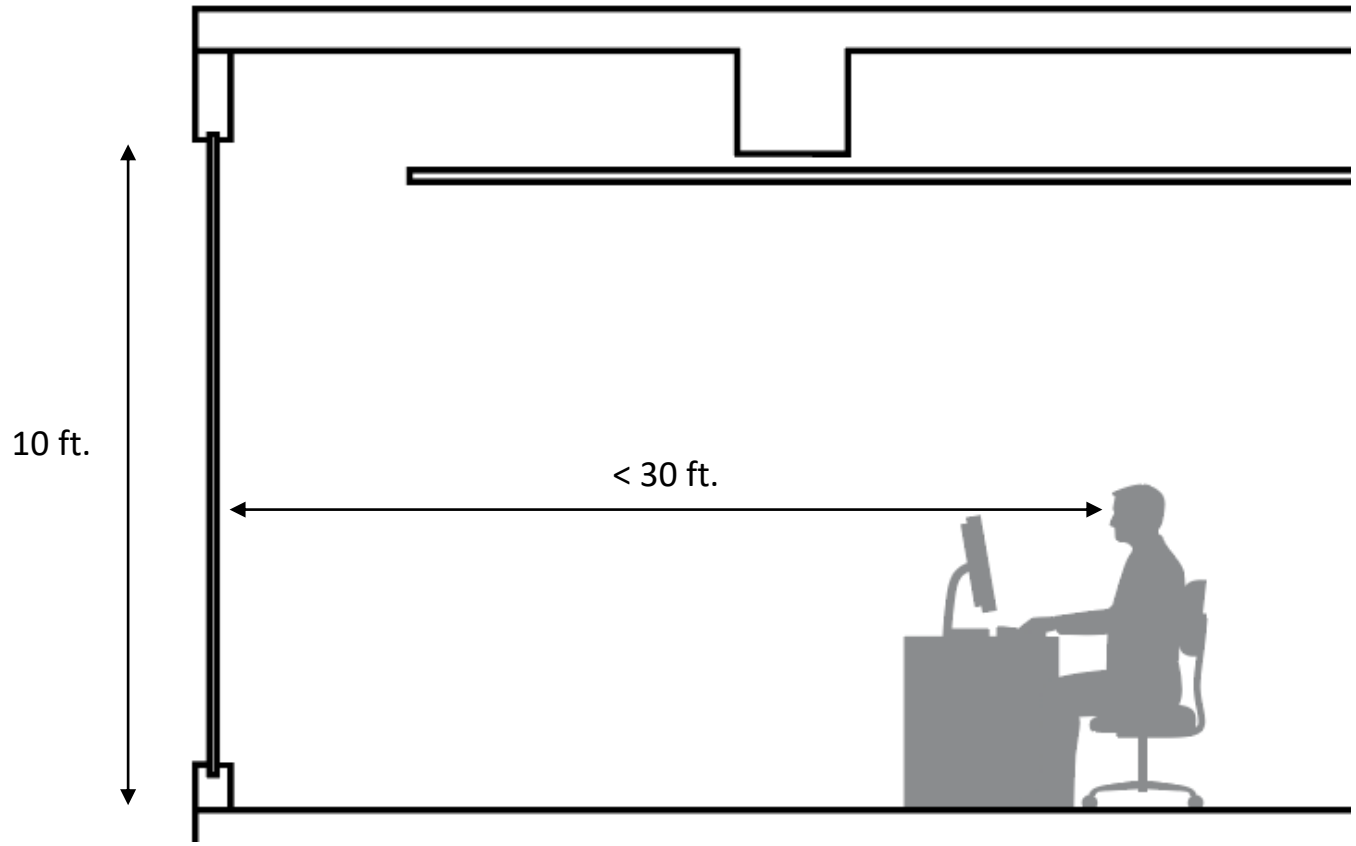
Figure: J. Sargent (Solemma)

A LEED Quality View meets the following two criteria:

Type 2: Can see 2 of 3 through vision glass:

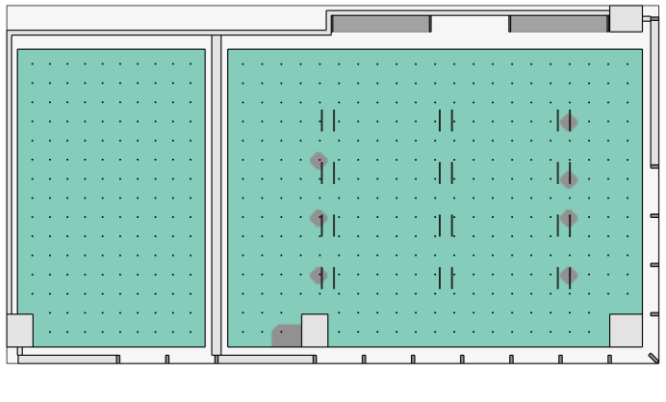
- *Nature / Art / Urban landmarks*
- *Objects > 25 ft.*

Type 3: Within $3\ x$ vision glass head height

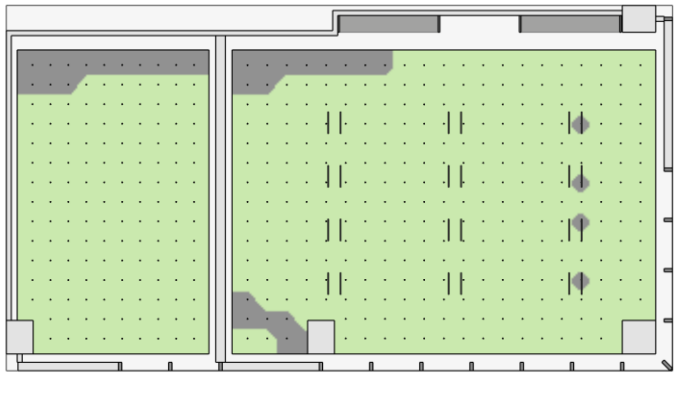


ClimateStudio LEED 4.1 Quality Views

Type 2

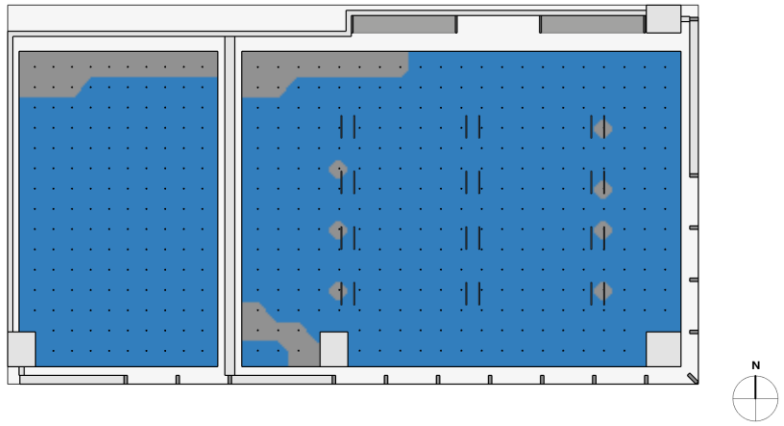


Type 3



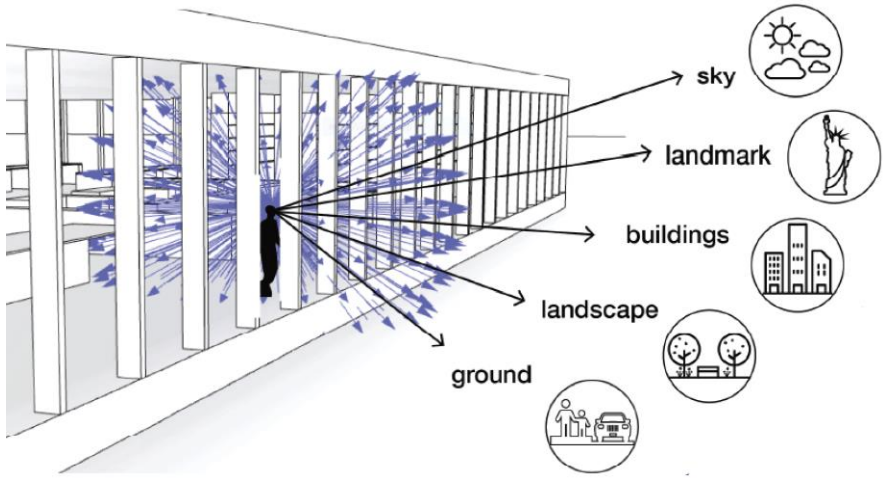
=

Pass/fail



Computational Design Approaches to View

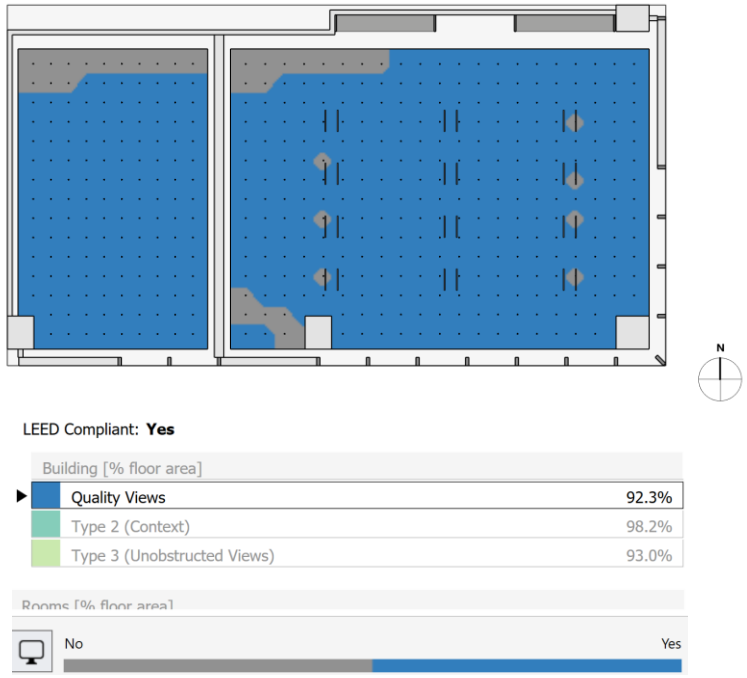
Content



- Objects of interest are tagged
- Content is analyzed at discrete viewpoints via raytracing;

Figure: I. Turan

Accessibility

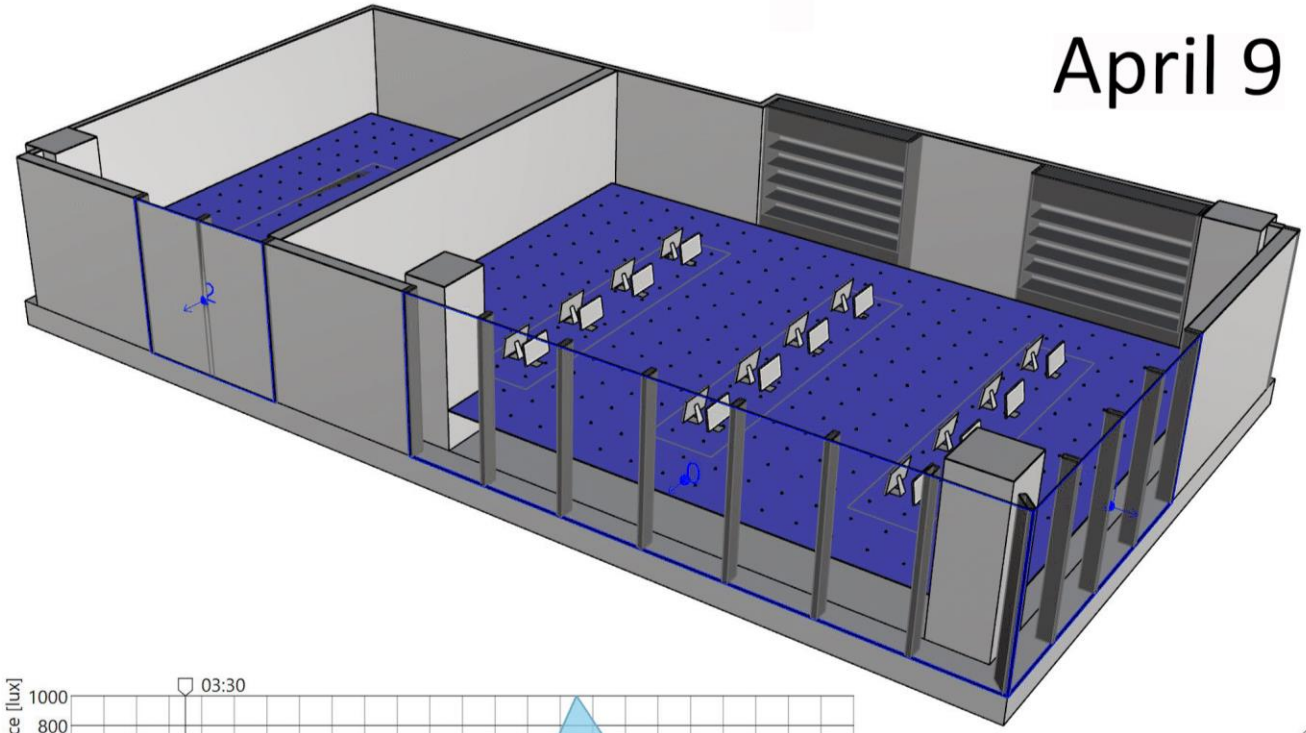


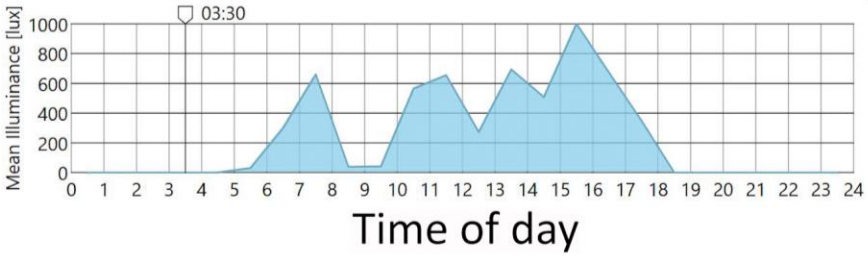
- Repeat analysis across a space
- Summarize at the room level

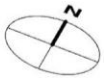
Screenshot: ClimateStudio

Clarity

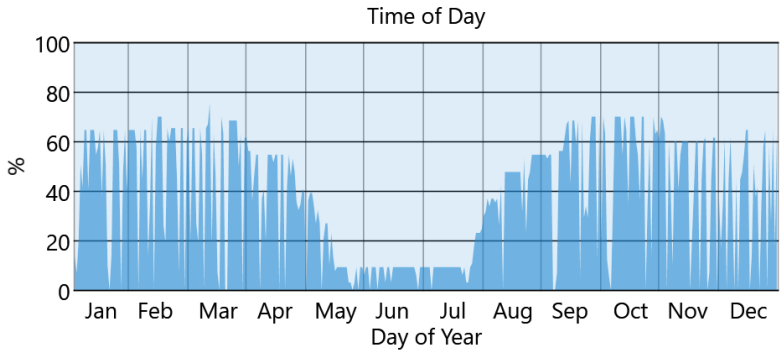
ClimateStudio Blind use by time of day







Annual shading schedule =
Access to view



Computational Design Approaches to View

Content

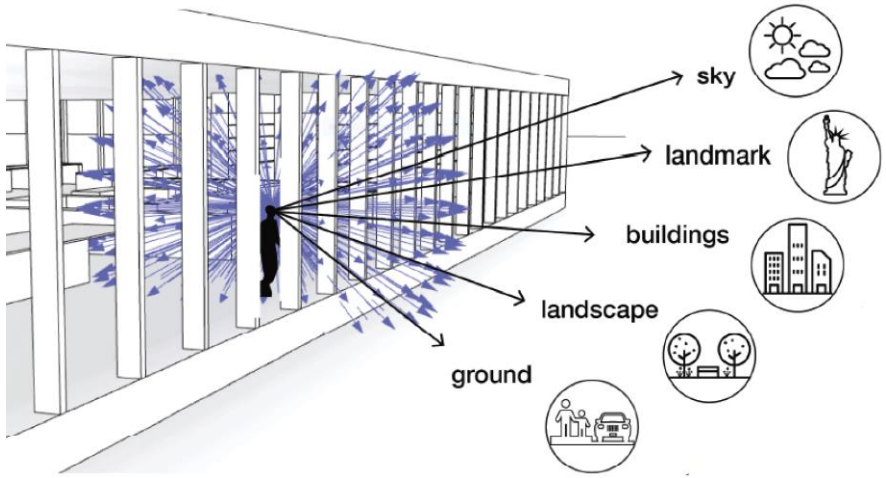


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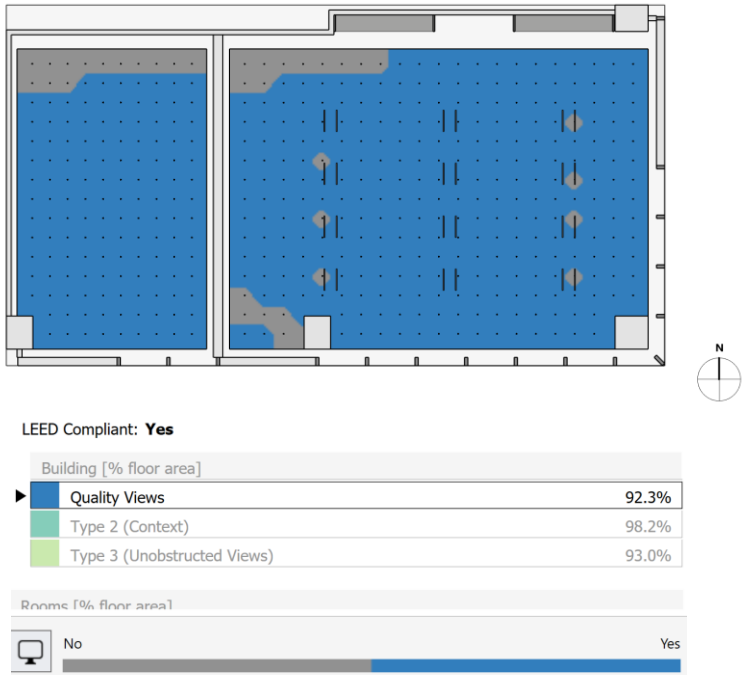
Figure: I. Turan

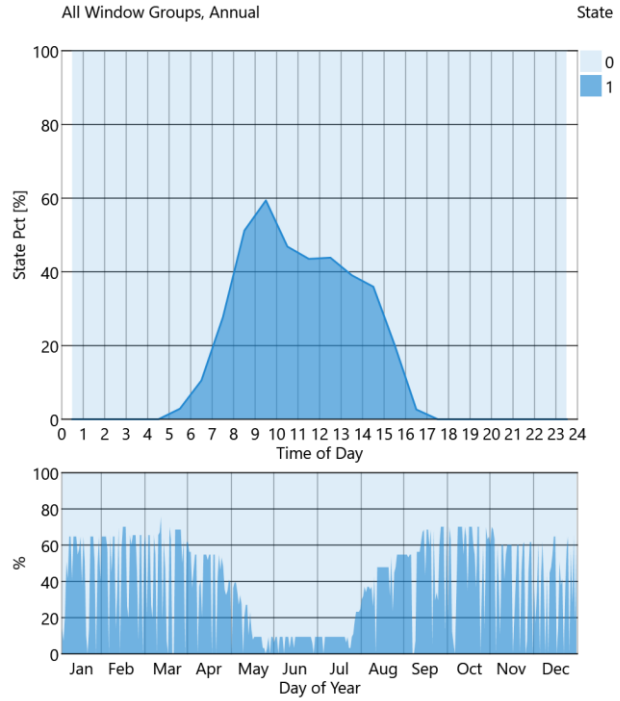
Accessibility



- Repeat analysis across a space
- Summarize at the room level

Screenshot: ClimateStudio

Clarity

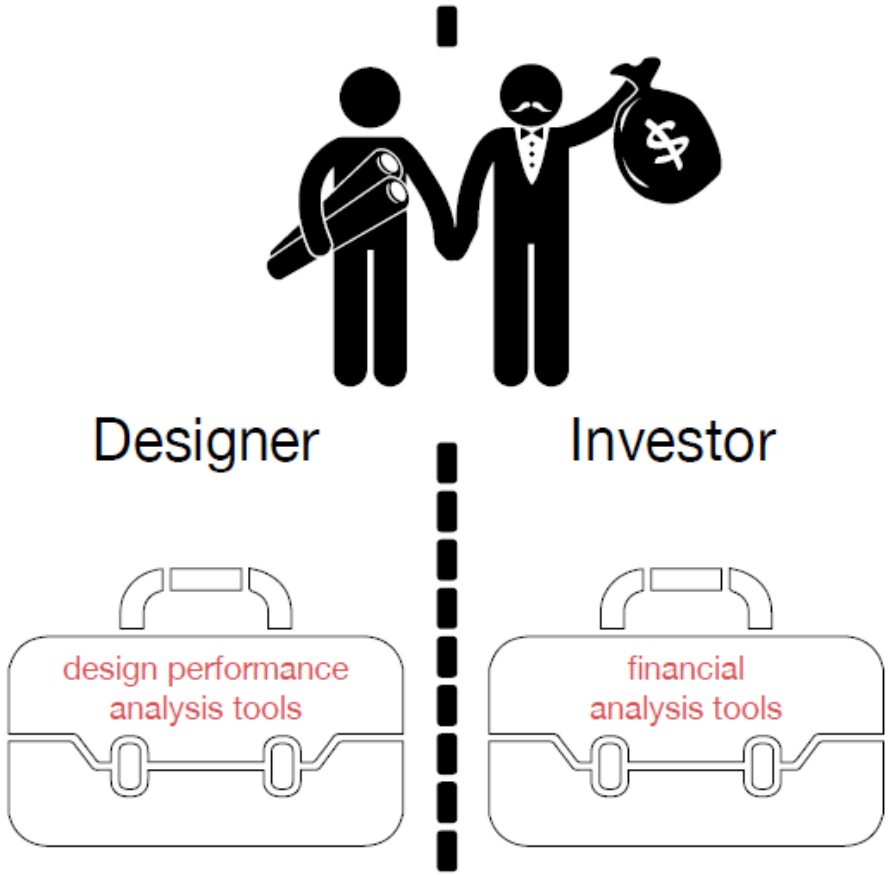


- State of the shading system

Screenshot: ClimateStudio

It remains unclear whether these metrics correspond to occupant evaluations of spaces

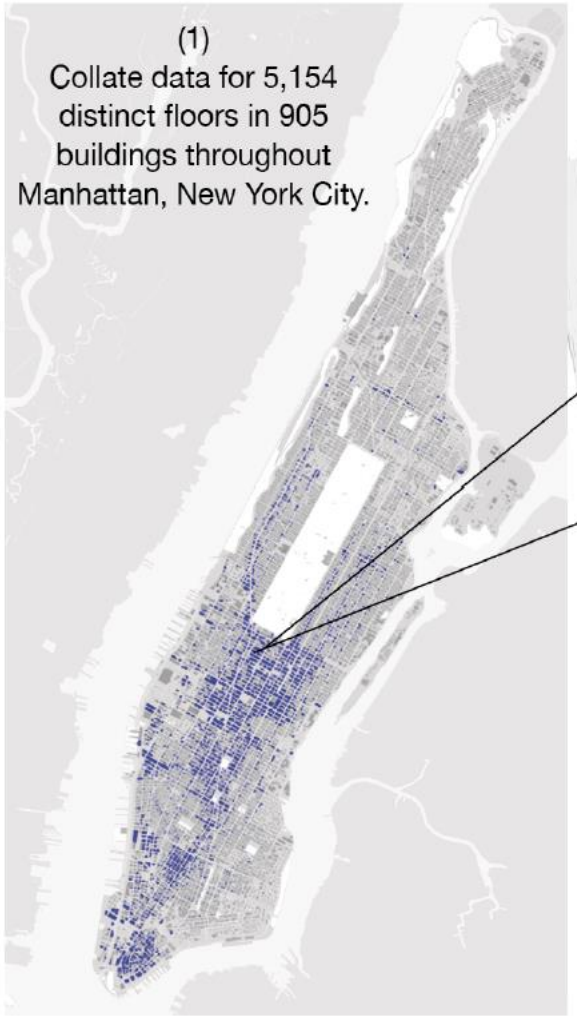
The Value of Daylight in Office Buildings



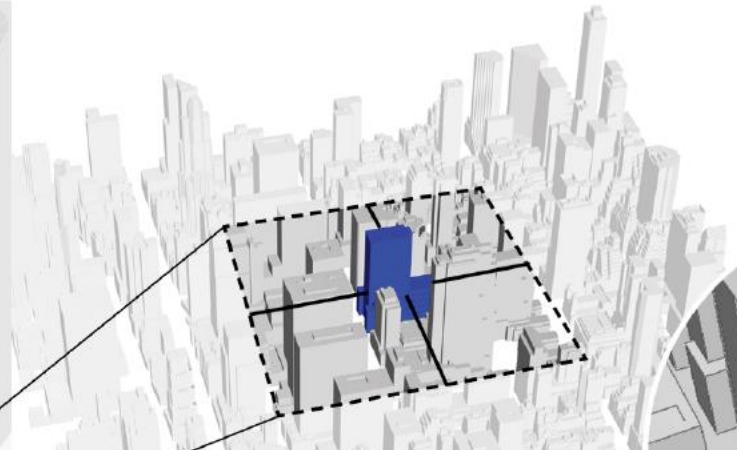
How can we overcome the conflict between carbon emissions and economics?

I Turan, A Chegut, D Fink and C Reinhart, 2020, The Value of Daylight in Office Spaces, Building and Environment, Volume 168, 15 January 2020, Article 106503

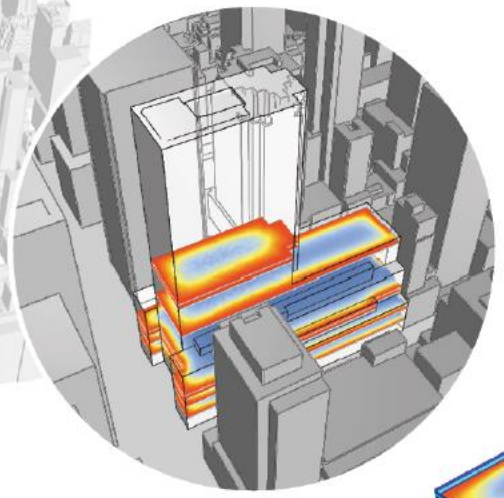
The Value of Daylight in Office Buildings



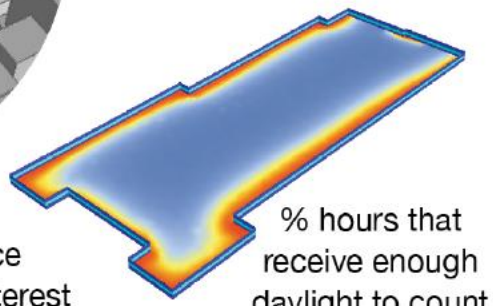
(1)
Collate data for 5,154 distinct floors in 905 buildings throughout Manhattan, New York City.



(2)
Create a 3d geometric model for each building and its adjacent context to be used in the floor-by-floor daylight simulation. Total extent of model is 800-ft by 800-ft (244-m by 244-m), roughly the size of a Manhattan block. The extent of the model accounts for the neighboring buildings that can significantly impact daylight access for the office space in question.



(3)
Simulate hourly illuminance through each floor plate of interest individually. Calculate floor-wide Spatial Daylight Autonomy ($sDA_{300/50\%}$) based on annual illuminance values.



% hours that receive enough daylight to count towards the floor-wide sDA metric.

0 100%

I Turan, A Chegut, D Fink and C Reinhart, 2020, The Value of Daylight in Office Spaces, Building and Environment, Volume 168, 15 January 2020, Article 106503

The Value of Daylight in Office Buildings

$$\log P_i = \alpha + \beta X_i + \delta g_i + \varepsilon_i$$

Price

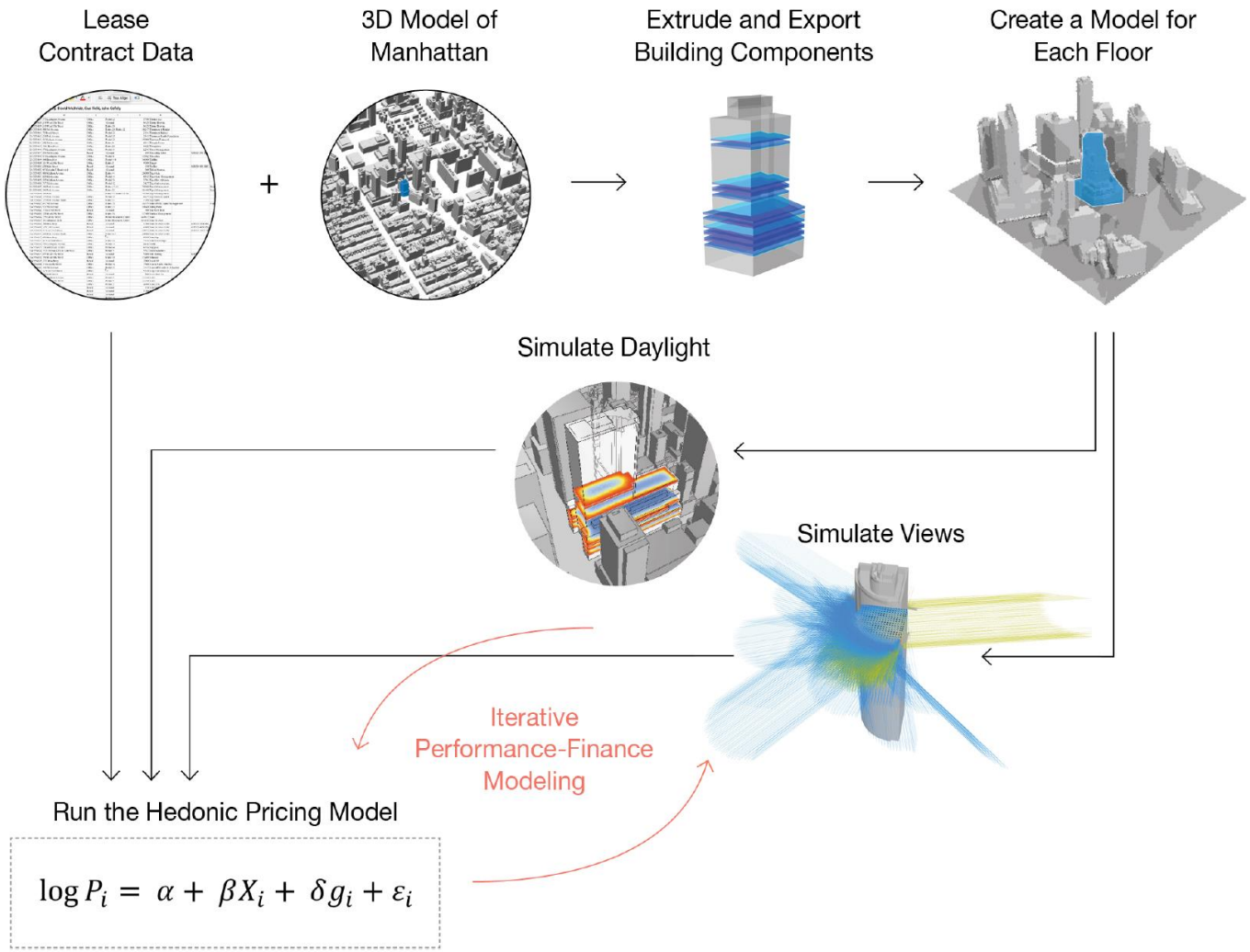
Factor in question
(e.g. daylight availability)

Hedonic characteristics include:
property type; age; building class; number of floors;
renovations; amenities; transportation accessibility;
investor type

- Spaces with access to high amounts of daylight (sDA> 55%) have a 5 to 6% value premium over occupied spaces with low amounts of daylight (sDA<55%)

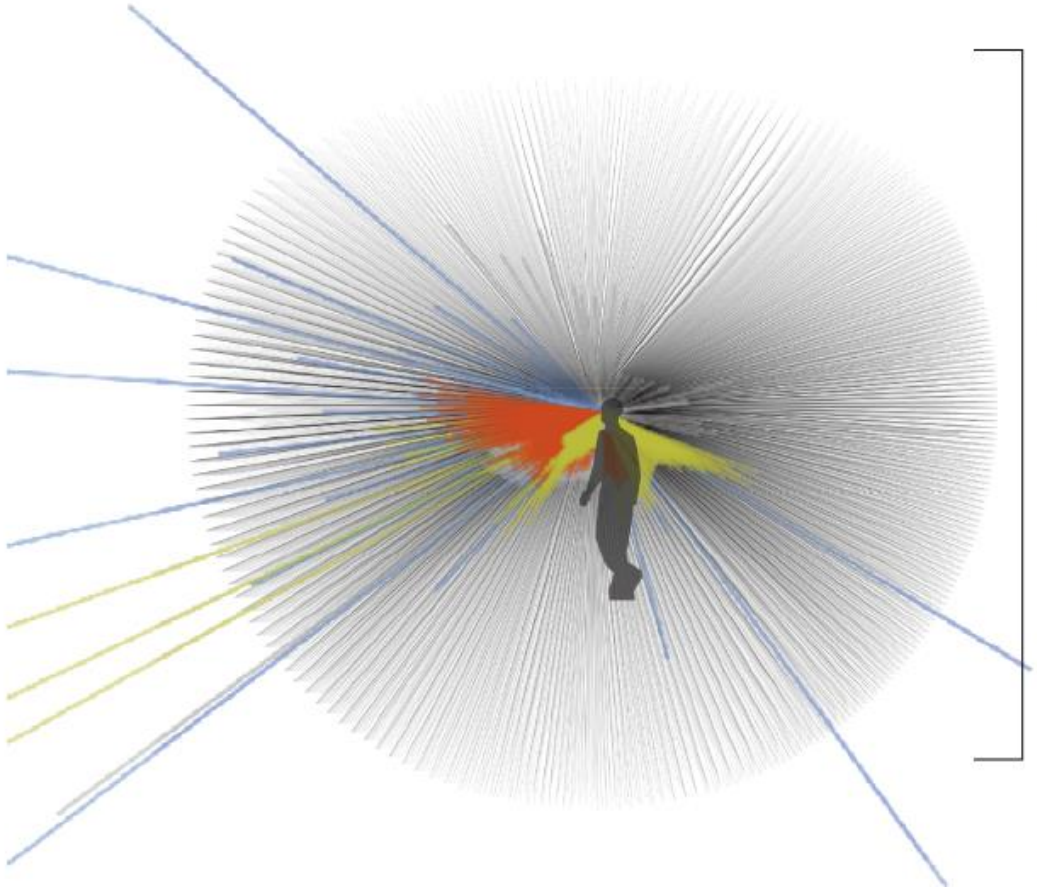
I Turan, A Chegut, D Fink and C Reinhart, 2020, The Value of Daylight in Office Spaces, Building and Environment, Volume 168, 15 January 2020, Article 106503

The Value of Daylight & View in Office Buildings



I Turan, A Chegut, D Fink and C Reinhart, 2021, Development of View Analysis Metrics and Their Financial Impacts on Office Rents, Landscape and Urban Planning, 215, 104193

The Value of Daylight & View in Office Buildings Proposed View Metrics



All rays cast from occupant eye level at one node

- indoor ray
- iconic landmarks and green spaces
- distant views of water and greater metropolis
- ground
- surrounding buildings

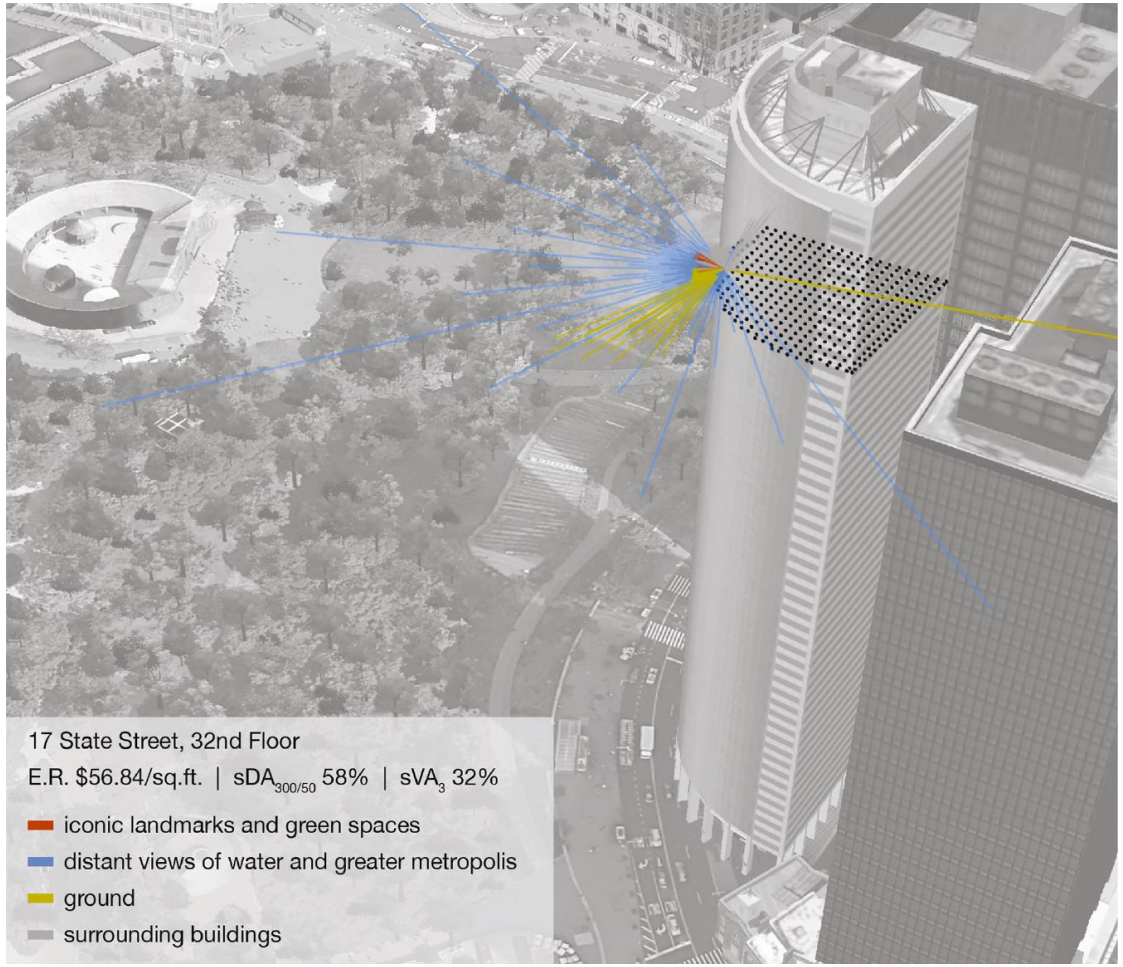
Minimum View Potential (MVP) for one node in the grid

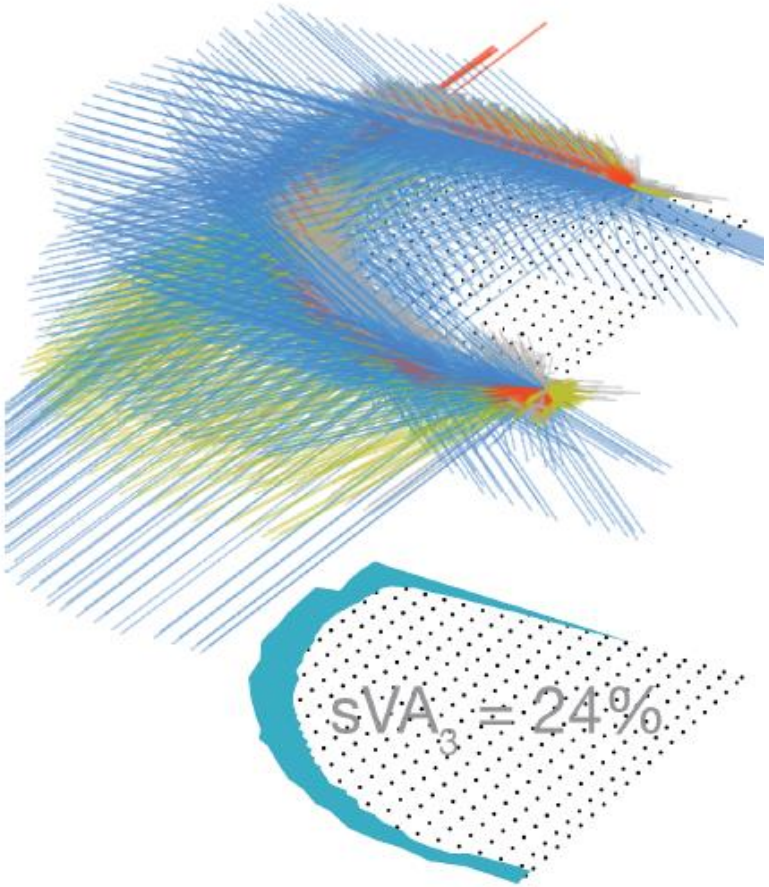
$$\frac{\text{outside rays: 959}}{\text{total rays: 6,111}} = 16\%$$

- Question 1: What is required number of content rays for a location to have a “minimum view potential”?

I Turan, A Chegut, D Fink and C Reinhart, 2021, Development of View Analysis Metrics and Their Financial Impacts on Office Rents, Landscape and Urban Planning, 215, 104193

The Value of Daylight & View in Office Buildings Proposed View Metrics

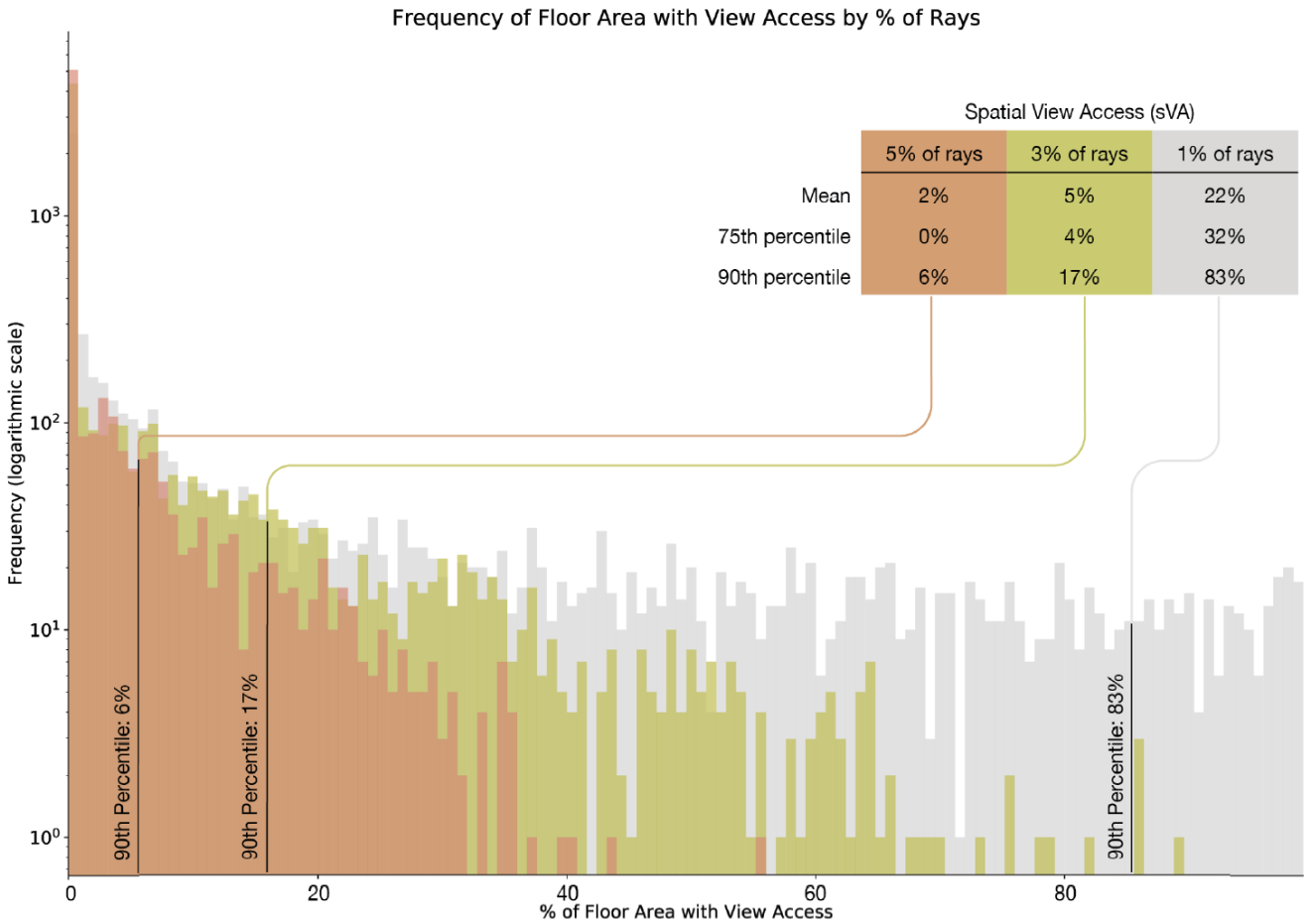




- Question 2: What percentage of a space needs to have a “view” for the overall space to have “spatial view access”?

I Turan, A Chegut, D Fink and C Reinhart, 2021, Development of View Analysis Metrics and Their Financial Impacts on Office Rents, Landscape and Urban Planning, 215, 104193

The Value of Daylight & View in Office Buildings Proposed View Metrics



- We decided that 3% MVP and 10% sVA3 correspond to high view access. In our dataset 16% of spaces accordingly have a “view”.

I Turan, A Chegut, D Fink and C Reinhart, 2021, Development of View Analysis Metrics and Their Financial Impacts on Office Rents, Landscape and Urban Planning, 215, 104193

The Value of Daylight & View in Office Buildings Combined Results

- The results show that spaces with high levels of daylight (55% and above sDA300/50%) have a 5 to 6% premium over spaces with low daylight (less than 55% sDA300/50%).

- Spaces with high access to views (10% and above sVA3) have a 6% premium over spaces with low access to views (less than 10% sVA3)

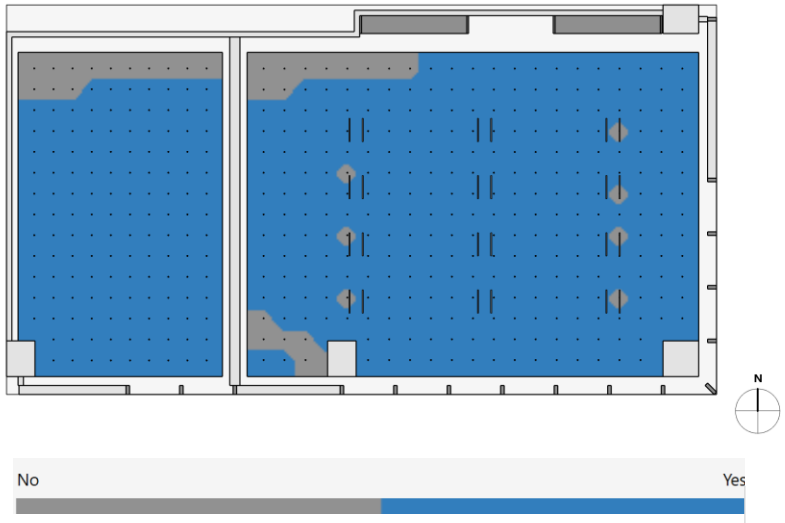
- The combined value of spaces with *both* high daylight and view access, similarly, is 6%, indicating that the impact of daylight and views together is significant but is not additive.

I Turan, A Chegut, D Fink and C Reinhart, 2021, Development of View Analysis Metrics and Their Financial Impacts on Office Rents, Landscape and Urban Planning, 215, 104193

What do different view metrics reward?

View Metric Comparison

LEED v4.1



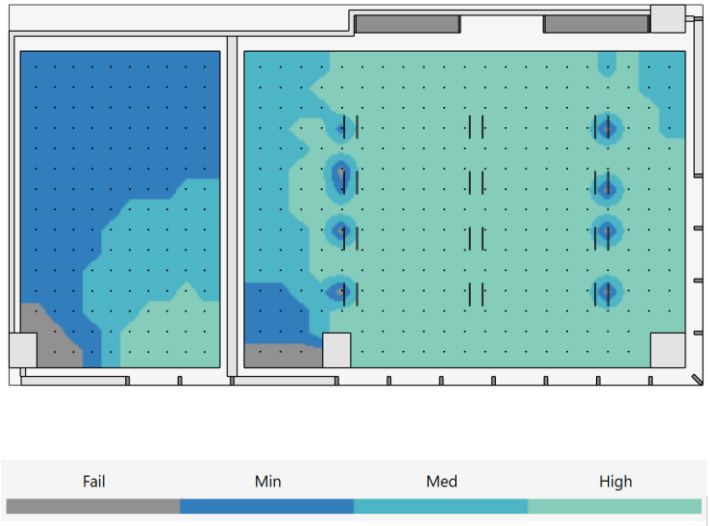
Metric Scale: Yes/No

Compliance: Both Type 2 (context & sky) and Type 3 (unobstructed) for at least 75% of regularly occupied area

Components Considered:

- Sky	Yes
- Ground	Yes
- Vegetation/Nature	Yes
- Art	Yes
- Urban landmarks	Yes

EN 17037



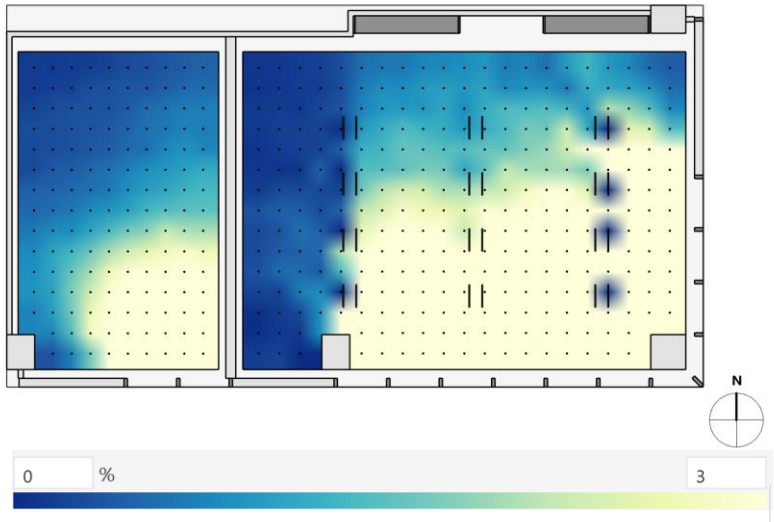
Metric Scale: Fail/Min/Med/High

Compliance: 3 assessments included; horizontal sight angle, outside view distance and Number of view layers

Components Considered:

- Sky	Yes
- Ground	Yes
- Vegetation/Nature	Yes
- Art	No
- Urban landmarks	Yes

MVP > 3%



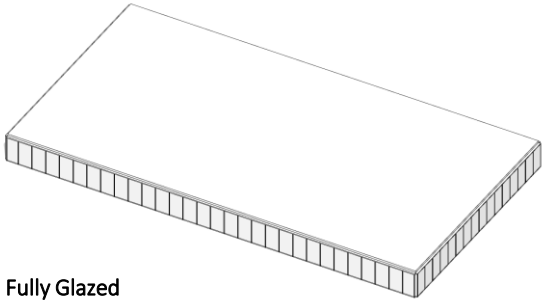
Metric Scale: 0-100%

Compliance: Measures the % of view (by solid angle) occupied by a specific feature. 10% sVA with a 3% MVP.

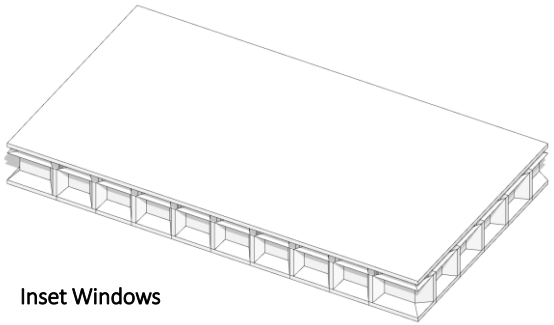
Components Considered:

- Sky	Yes
- Ground	Yes
- Vegetation/Nature	Yes
- Art	Yes
- Urban landmarks	Yes

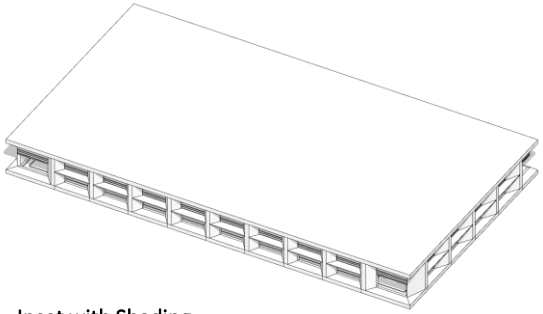
Façade Geometry Comparison



Fully Glazed

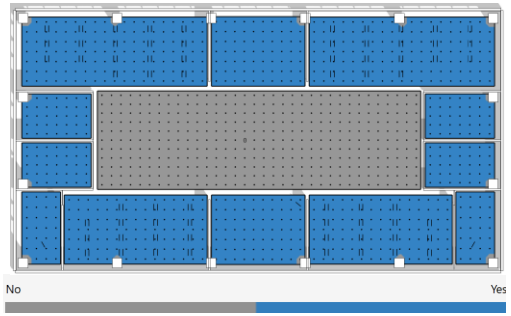


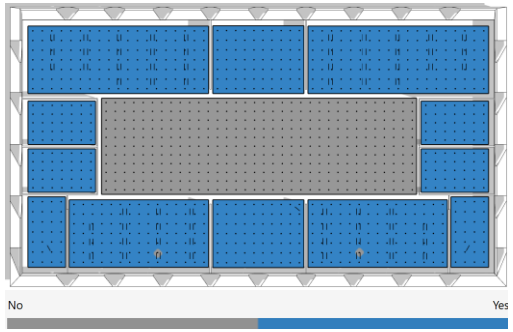
Inset Windows

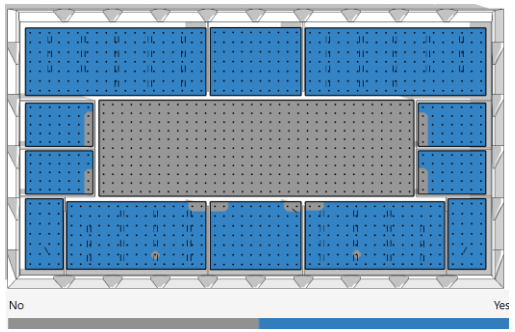


Inset with Shading

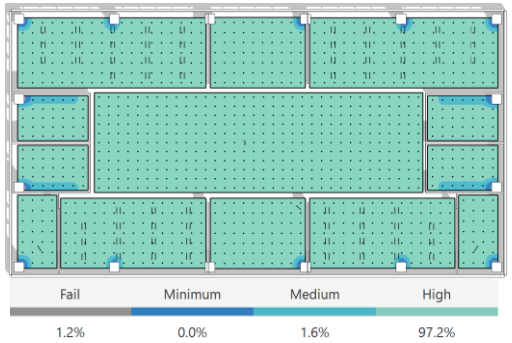
LEED v4.1

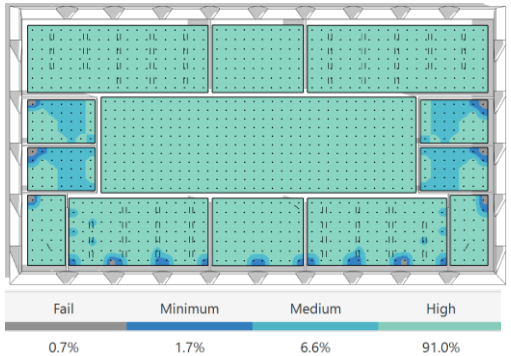




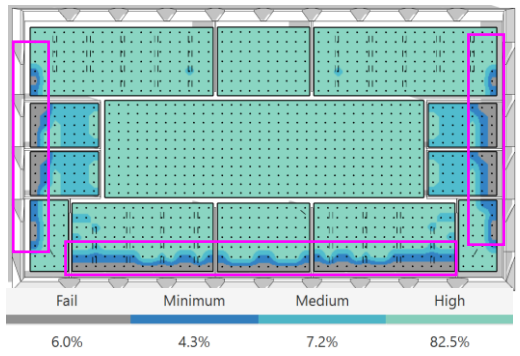


EN 17037

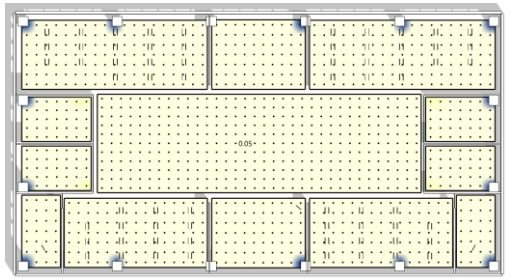




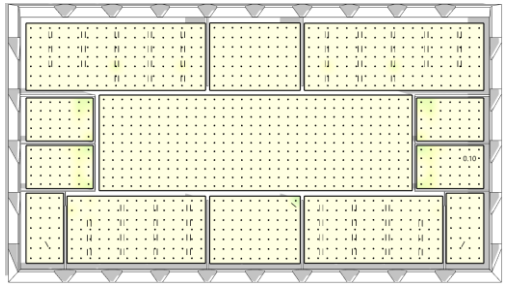
Edge penalties



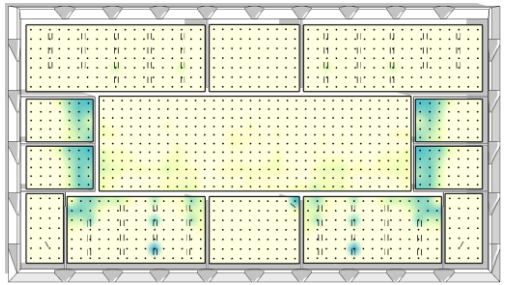
MVP > 3%



Avg Factor 11.7%



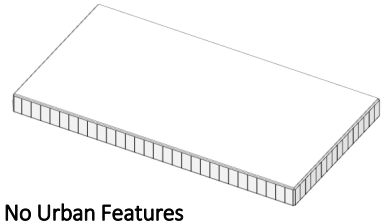
Avg Factor 8.3%



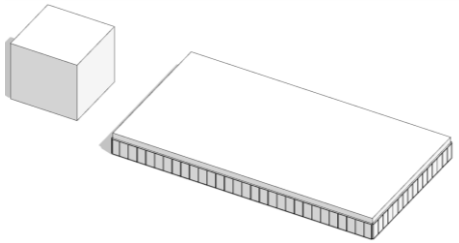
Avg Factor 6.4%

Slide: N Tarkhan

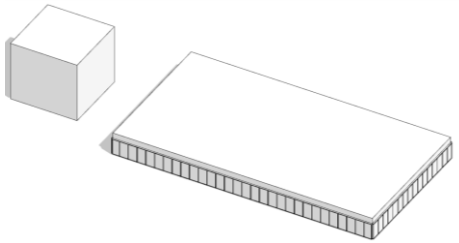
Feature Comparison



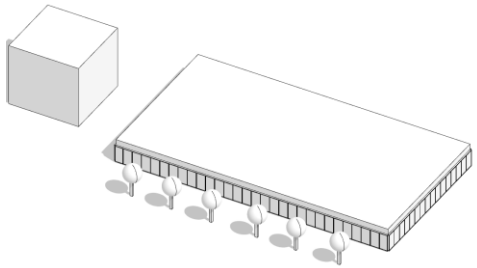
No Urban Features



Art Feature- 20ft from facade

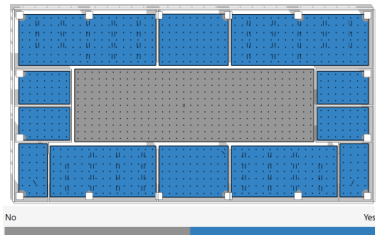


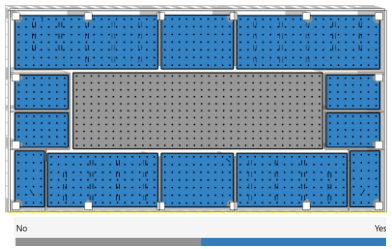
Art Feature- 30ft from facade



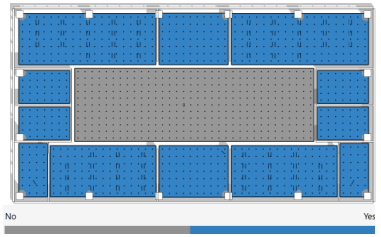
Art Feature- 30ft from façade
+ Nature

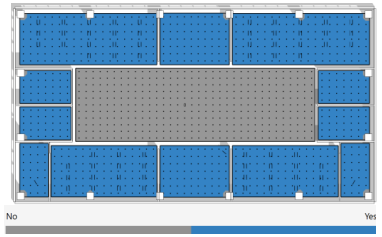
LEED v4.1



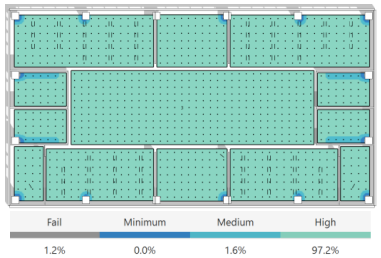


LEED score remains unchanged- 69% in all cases

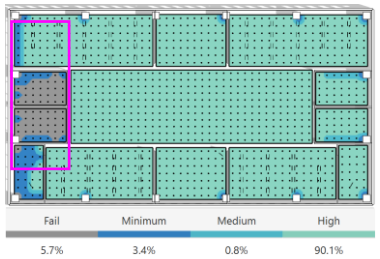


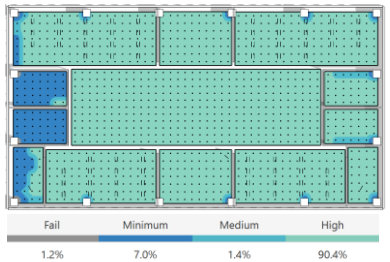


EN 17037

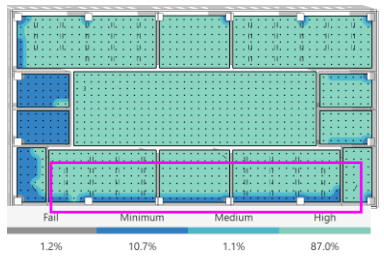


External object too close to façade receives low score

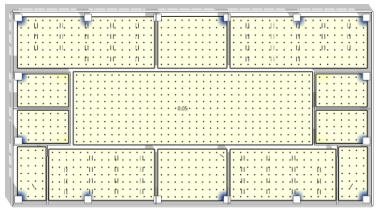




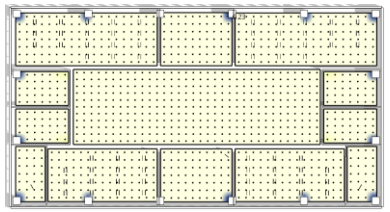
External object too close to façade receives low score



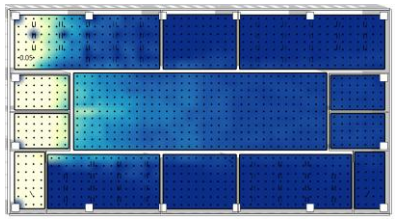
MVP > 3%



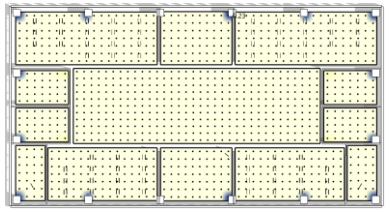
Avg Factor 11.7%



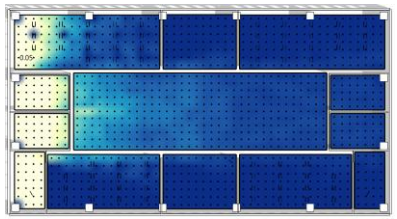
Avg Factor (Vision) 11.7%



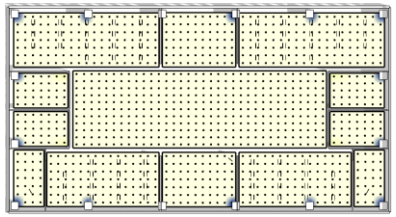
Art



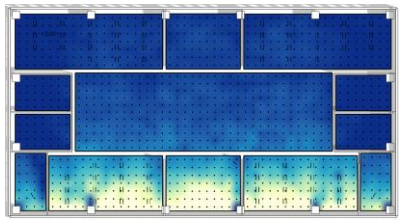
Avg Factor (Vision) 11.7%



Art



Avg Factor (Vision) 11.7%



Nature

Slide: N Tarkhan

Concluding Thoughts

- From a design computation perspective, we have the capabilities to predict and combine aspects of view content, access and clarity in real time.
- Existing metrics have conflicting messages.
- Minimum view potential is promising for design applications but needs further validation as a higher rent ≠ high occupant satisfaction.
- We need coordinated human subject studies to validate and compare existing metrics against.

Thank You