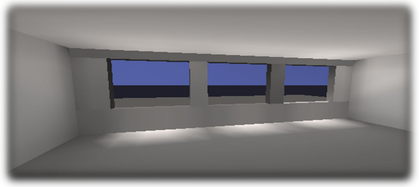
PennState College of Education | CSATS Center for Science and the Schools | **Research Experiences for Teachers** | PennState College of Engineering ARCHITECTURAL ENGINEERING

Quantifying Annual Daylighting for LEED Certification



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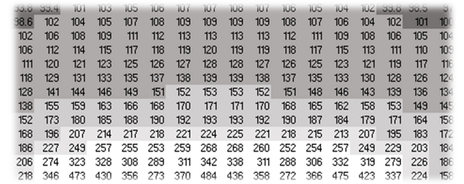


Introduction

- LEED is a green building rating system[2]
- Benefits of LEED certification include:
  - economic
  - health
  - environmental
- Design and construction projects earn credits by incorporating green building features into designs
- The total credits determine a project's certification level
- Daylight credits are determined through one of three different options
- Options one and two are based on computer simulations
- Results from Option 1 and Option 2 produce nearly opposite results[1]

Objective

- Develop a revised approach to quantifying annual daylighting for LEED Option 2 (rather than a metric of one day at 9 am and 3 pm)
- Establish better agreement with LEED Option 1 (a more detailed hourly simulation leading to the calculation of Spatial Daylight Autonomy)

Methodology

Utilizing lighting simulation software, Spatial Daylight Autonomy (sDA) was calculated for a room across three window orientations. Different simulation approaches were then applied in an attempt to achieve results close to the sDA results (the Option 1 method). Room distributions produced by different sky and window shading conditions were used to estimate the daylight illuminance across a space based on the amount of light entering the room through the window at two U.S. locations.

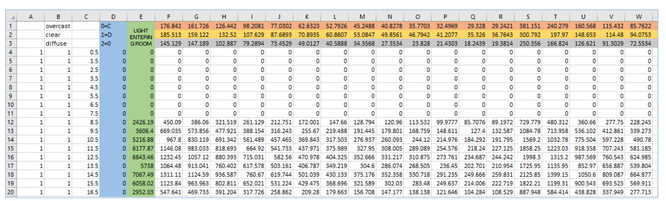
Results

Option 1 vs One Distribution
Huron, SD

	South	West	North
Option 1 Hourly sDA	**40.1%**	**57.2%**	**64.4%**
Clear	62%	68.2%	71.6%
Overcast	34.1%	37%	39.9%
Diffuse	40.3%	42.7%	44.7%

Option 1 vs Two Distributions:
Diffuse (shades down) + Clear
Huron, SD

	South	West	North
Option 1 Hourly sDA (Huron, SD)	**40.1%**	**57.2%**	**64.4%**
Two Distributions	63.9%	65.9%	71.6%



Option 1 vs Three Distributions
Diffuse (shades down) + Clear + Overcast
Huron, SD

	South	West	North
Option 1 Hourly sDA	**40.1%**	**57.2%**	**64.4%**
Three Distribution	40.8%	56.7%	63.9%

Option 1 vs Three Distributions
Diffuse (shades down) + Clear + Overcast
Miami, FL

	South	West	North
Option 1 Hourly sDA	**64.9%**	**67.7%**	**77.8%**
Three Distribution	64.8%	73.9%	86.5%

Summary

This study considered daylight distributions under three different sky/window combinations and tested the performance of applying one, two, and three of these to the hours throughout the year in estimating the sDA.

The use of all three performed best.

Conclusion

- Results are promising that a simplified method based on three different room daylight distributions could be used to estimate the sDA
- This revised Option 2, while simplified, requires more input data than the current Option 2 since shades down hours and hourly window illuminance are required
- More work has to occur to scale this method to a whole building

Future Work

The development of simplified methods of computing shades down hours and window illuminance for each space in a building may be required for buildings with exterior obstructions since these data increase the complexity of this revised Option 2 approach.

References

[1]Esmailian, Maryam. "A Study of Daylight Modeling Approaches Applied in LEED." (Draft) *The Pennsylvania State University*, 2021.

[2]"LEED v4.1 Building Design and Construction." [PDF] *LEED v4.1 | U.S. Green Building Council*, www.usgbc.org/leed.

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