



U.S. Department of Energy  
Energy Efficiency and Renewable Energy

# Daylighting

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# Benefits of Daylighting

- Human performance
- Environmental advantages
- Economic impact





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# Human Performance Benefits



# Daylighting Studies

- Daylighting in Schools
  - PG&E/Heschong Mahone
  - [www.h-m-g.com](http://www.h-m-g.com)
    - students spending one year in a daylit school progressed
    - 20 % faster on math tests
    - 26% faster on reading tests
- Skylighting and Retail Sales
  - PG&E/Heschong Mahone
  - [www.h-m-g.com](http://www.h-m-g.com)



# Daylighting Studies

- Daylighting in Schools – Reanalysis
  - CEC/NBI/Heschong Mahone
  - [www.newbuildings.org](http://www.newbuildings.org)
- Daylight and Productivity
  - Lighting Research Center 9/01
  - [www.lrc.rpe.edu](http://www.lrc.rpe.edu)



# North Carolina study

- In Johnston County, North Carolina, students attending daylit schools outperformed students in non-daylit schools by 5 to 14%.
- Daylit schools saved average of \$165,000 on energy costs (64% less energy than typical schools in same county)

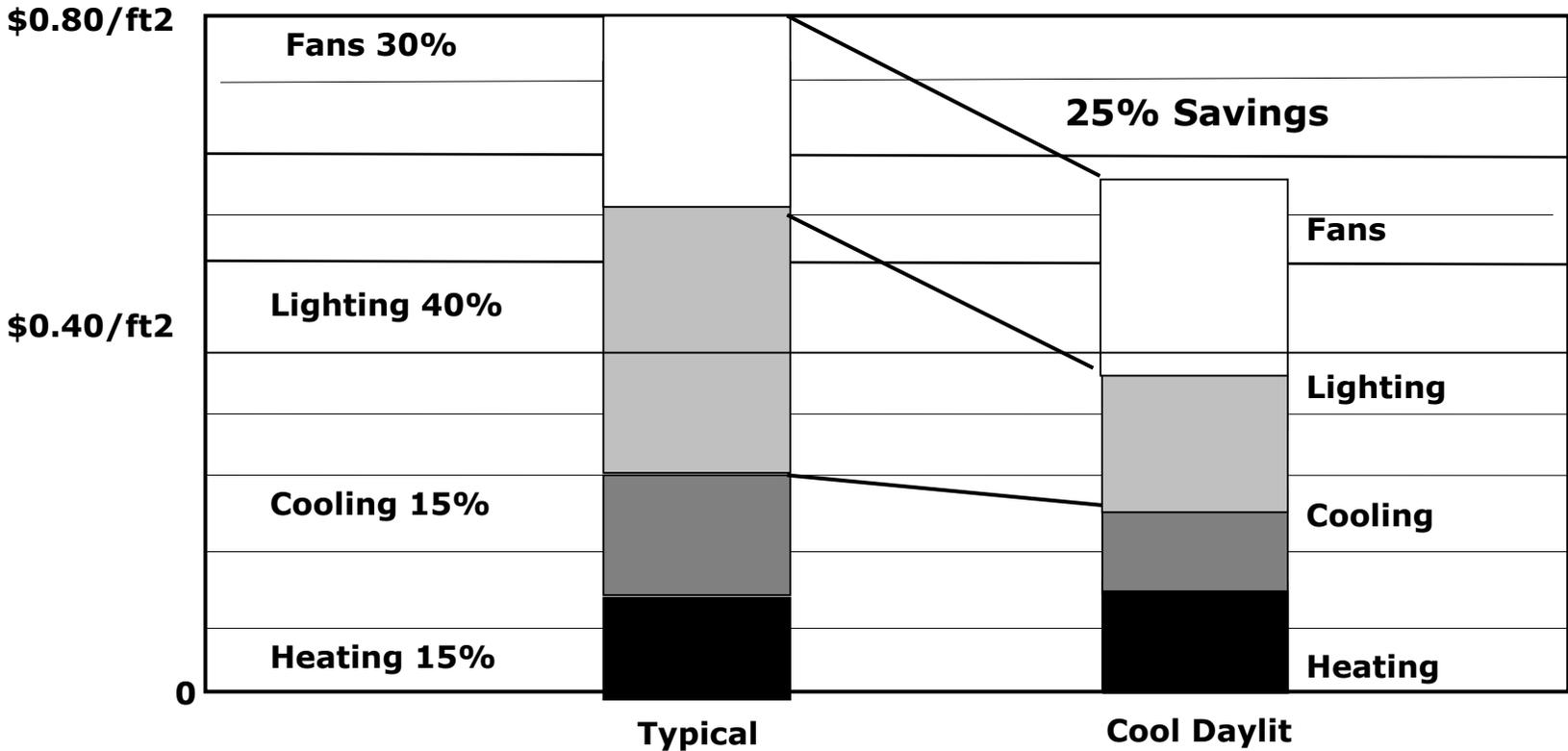


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# Economic Benefits



# School Energy End Uses – Potential Savings





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# How does daylighting work?



## Forward to IES 2000 Handbook – 9<sup>th</sup> Edition

*“The emphasis in the ninth edition is on quality.... IESNA has, however, always recommended quantity of light for specific applications or visual tasks. As a result, many practitioners often mistook the IESNA system of recommended illuminance (quantity) as the primary, or even sole criteria, for lighting design. This Handbook introduces a new formal system of addressing quality issues...”*



# Daylighting...

- Is the use of indirect natural lighting to illuminate the interior of buildings reducing the need for electric lighting



# Daylighting and energy use...

- **Cool daylighting** is a holistic, design strategy that facilitates the effective utilization of daylight to reduce the need for artificial illumination, without increasing **COOLING LOADS** or causing **UNWANTED GLARE**

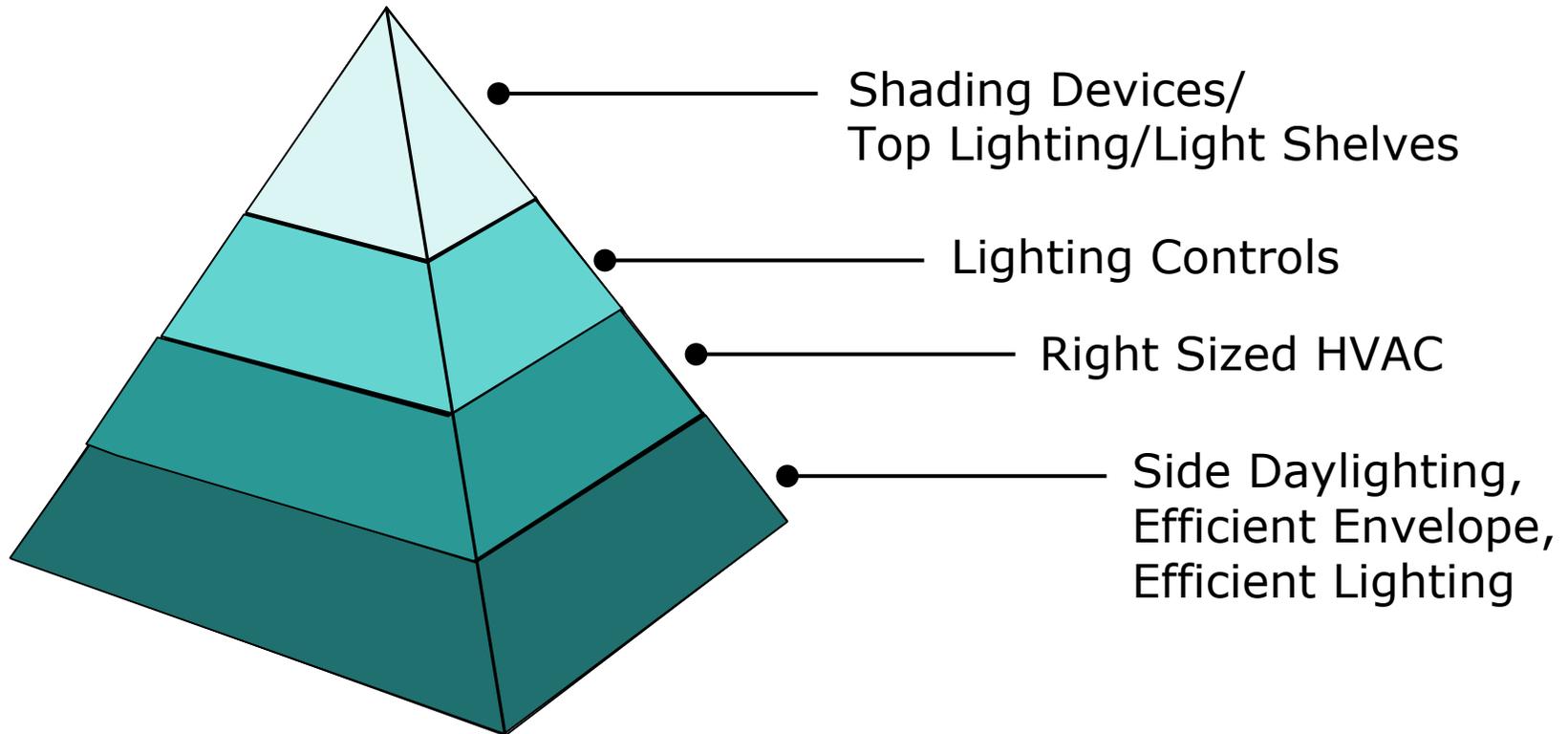


# Daylighting has many names....

- Toplighting
  - Skylights
  - Monitors
  - Pop-ups
  - Tubular skylights
  - Typically – horizontal glass
- Sidelighting
  - Windows in general
  - Clerestories
  - View windows
  - Typically – vertical glass



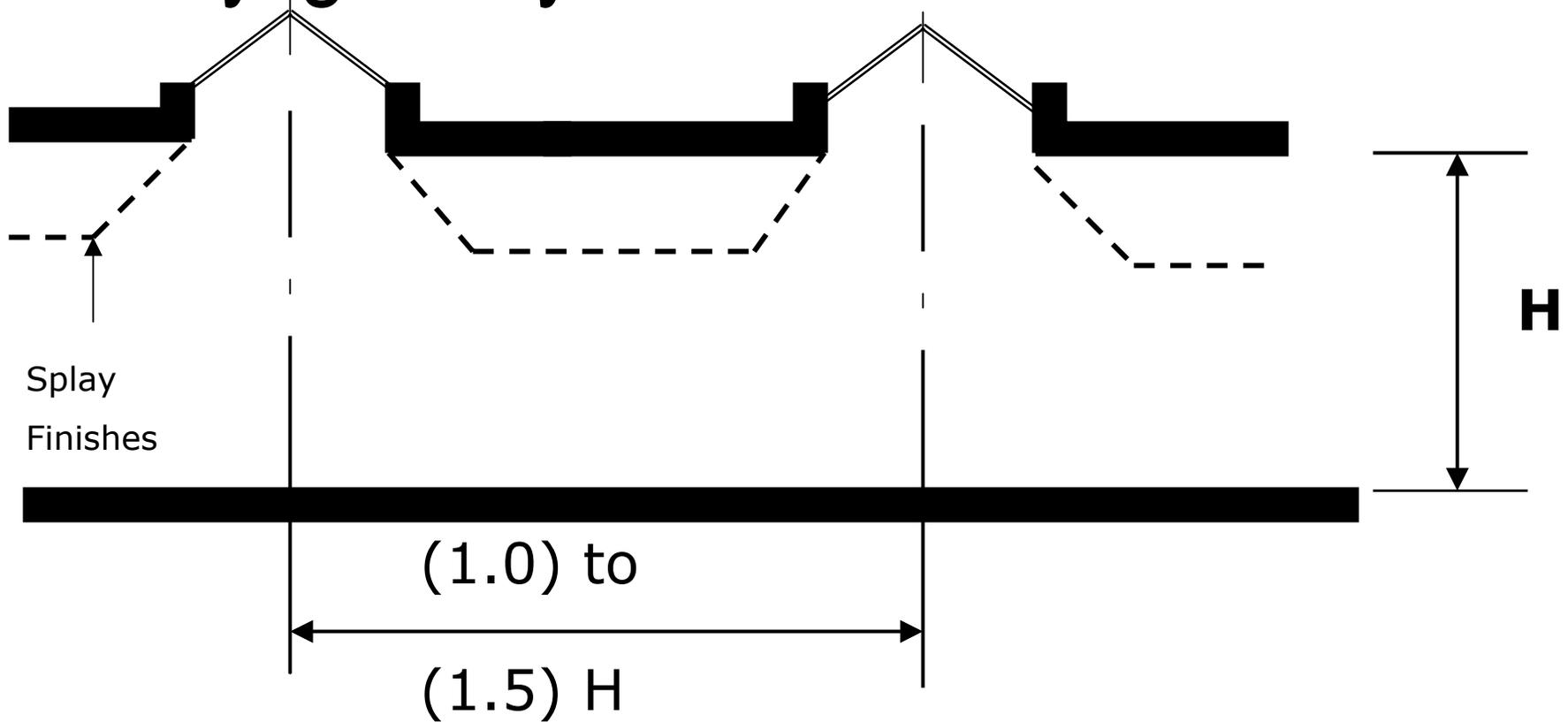
# Prioritization – The Daylighting Pyramid



**Prioritize Design Strategies Based on First Cost**



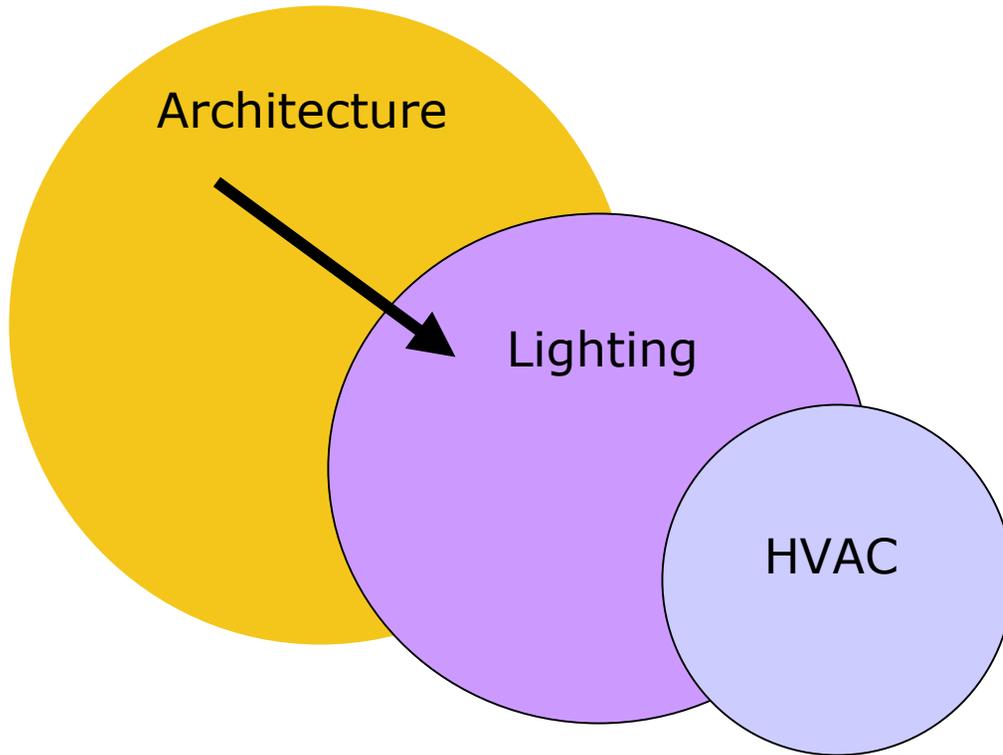
# Skylight Layout Guidelines



TOTAL SKYLIGHT AREA / FLOOR AREA = 3-6%



# Work from “Macro” to “Micro” Scale



Architecture sets  
the stage for...

Successful lighting  
and HVAC



# Daylight Frequently Occupied Spaces



**Occupied vs. Circulation Spaces**



# It Doesn't Stop With Lights

- Less artificial lighting = lower heat gain to spaces.
- Less heat gain to spaces = less cooling demand.
- Less cooling demand = less fan and pumping energy.

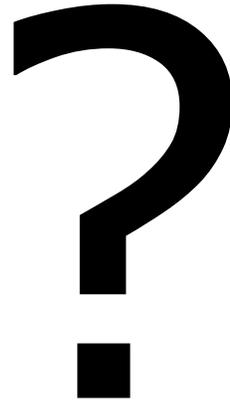




# Daylighting Aperture Placement

- Question:

Why are electric lights generally not placed on walls?



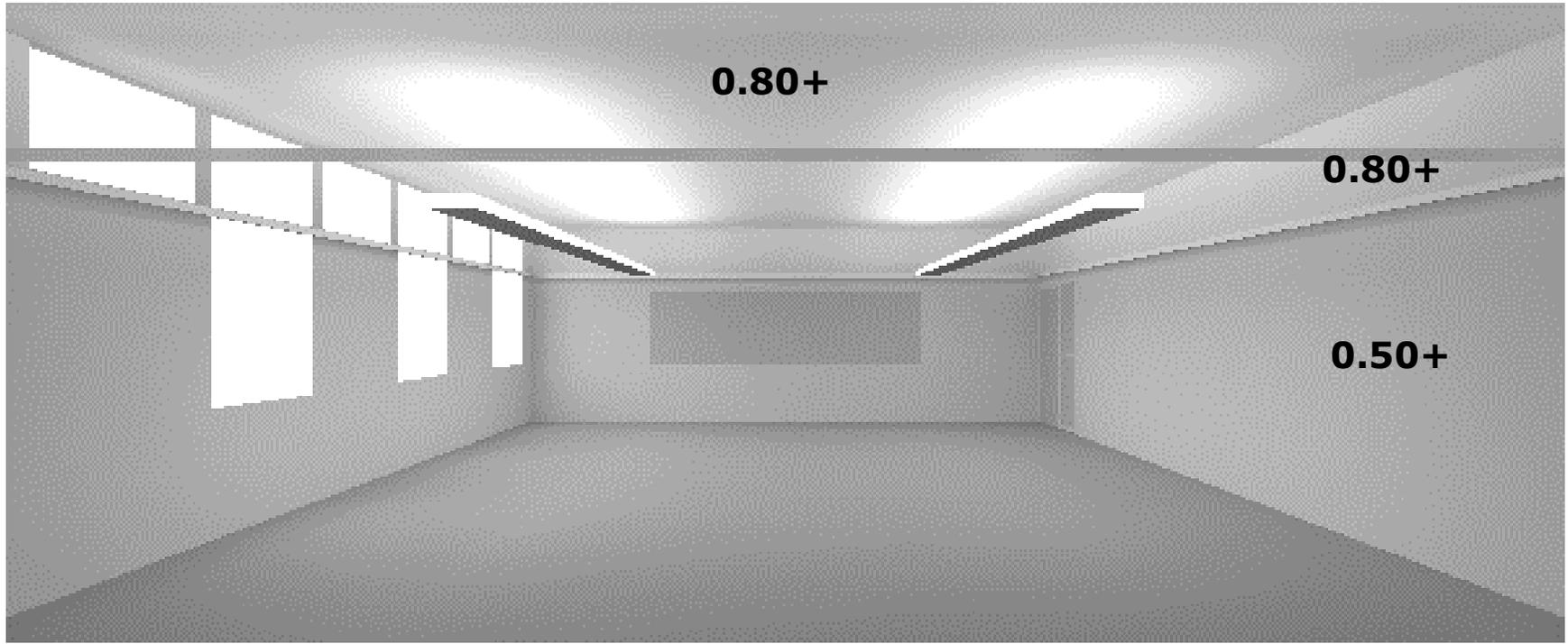


# Daylighting Aperture Placement

- Answer  
The amount of light (illuminance) is important, but brightness (luminance) is equally important. We want footcandles, but without excessive contrast and glare.



# Interior Finishes - Reflectance



**Minimum Reflectance Values**



# CLASSROOM: Lighting Base Case & Recommended

(12) 3-lamp Troffers = 1.22 W/sf

(12) 2-lamp Indirect = 0.82 W/sf,  
0.54 W/sf - daylight

**BASE CASE (70 fc)**

**RECOMMENDED (35 fc)**



# Occupancy – User Satisfaction

## User Training

- Daylighting Intent
- Lighting Controls
- Window Treatments

## Finish Lighting Controls

## Commissioning

- Make it **HAPPEN**
- (3) follow up visits





# What is WRONG with This Picture – Congress Elementary School (BEFORE)?





# What is RIGHT with this Picture Congress Elementary School (AFTER)?





# Case Study: Clerestory Lighting



**Chilton High School**  
Chilton, WI  
Architect: Hoffman



# Durant Road Middle School, Raleigh, NC





# Durant Road Middle School Raleigh, NC

## Design features:

- Orientation of building to reduce heat gain
- Radiant barrier on the roof to reflect 90% of the radiant heat
- Low-e glazing
- Smaller chiller required due to reduced cooling load of school
- Energy management system controls the outside air circulation to correspond with occupancy level of school

Capacity	1,300 students
Grade Level	6-8
Size	149,250 sq.ft.
Budget	\$15,983,526
Award Cost	\$12,330,986
Completed	1995
Estimated annual savings	\$21,000



# *Its up to you.....*

- Failure to capitalize on these benefits can lead to wasted and costly lost opportunities, and unnecessarily reduced performance occupants, *for the lifetime of the building!*