



The Second U.S.-China Energy Efficiency Forum

The Role of Daylight in Achieving Ultra-Low-Energy Buildings

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Neill Digert, Ph.D., MIES

Vice President of Product Enterprise

Solatube International, Inc.



Countries around the globe are experiencing an energy crisis!



The World's enormous design and construction market is focused on energy-efficient retrofit and innovative, ultra-low energy new construction.

The desire to halt global warming is creating an awareness and need for sustainable buildings, communities, and societies.



Energy Policy is at the forefront of governmental initiatives in nearly every country.

China needs to increase its generation capacity by over 1,312 GW between 2006 and 2030. Source: International Energy Agency, "World Energy Outlook 2007 – China and India Insights", pg. 317



Countries are tackling Global Warming and Climate Change by encouraging renewable & low carbon energy sources.



As a result, Government and Code Authorities are Single-mindedly Supporting use of Site-based, building integrated Photovoltaics (PV) as a solution.

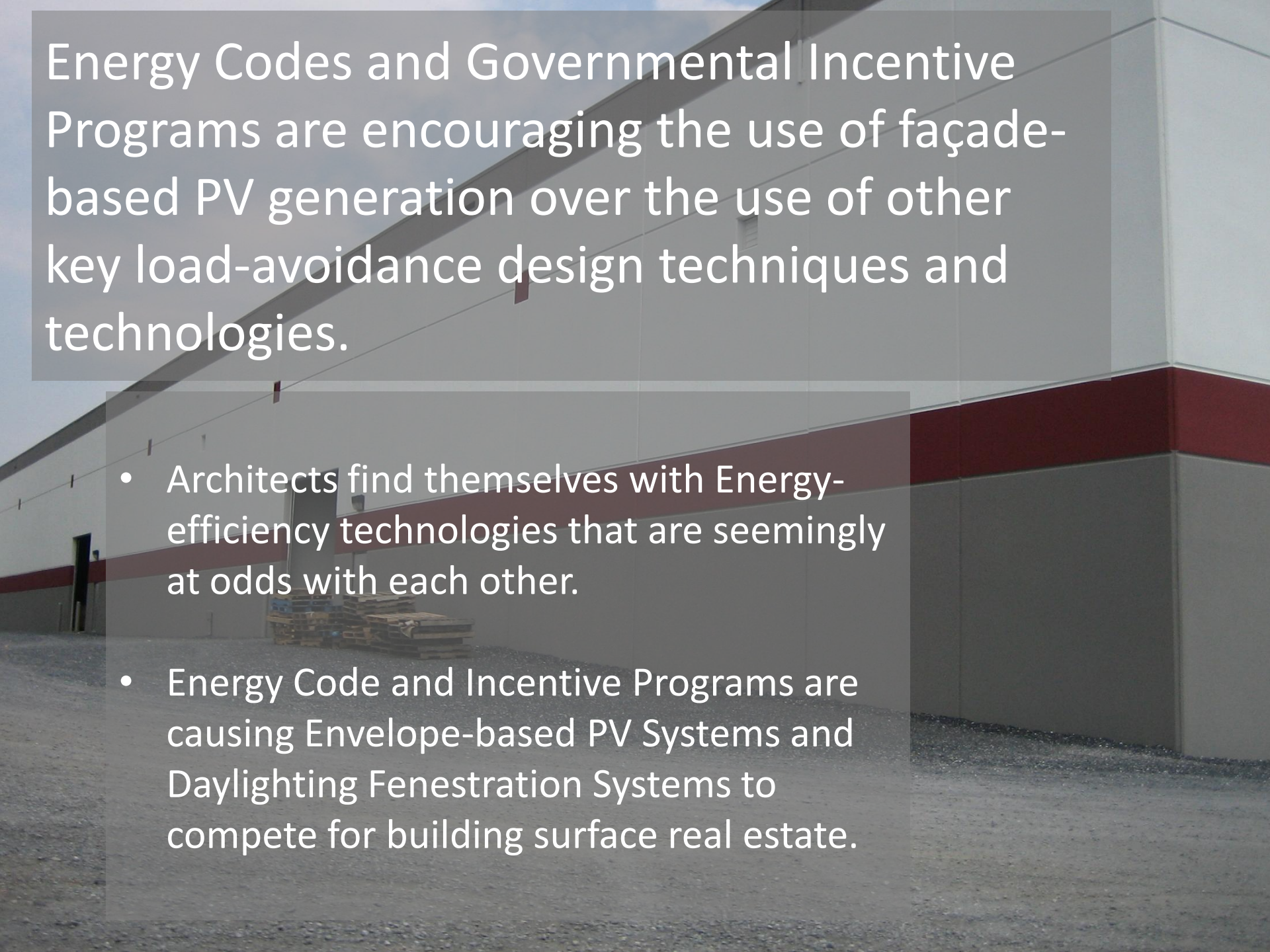




The Sun:

An important element of ultra-low energy sustainable Building design.

The use of Daylight and PV need not be mutually exclusive.

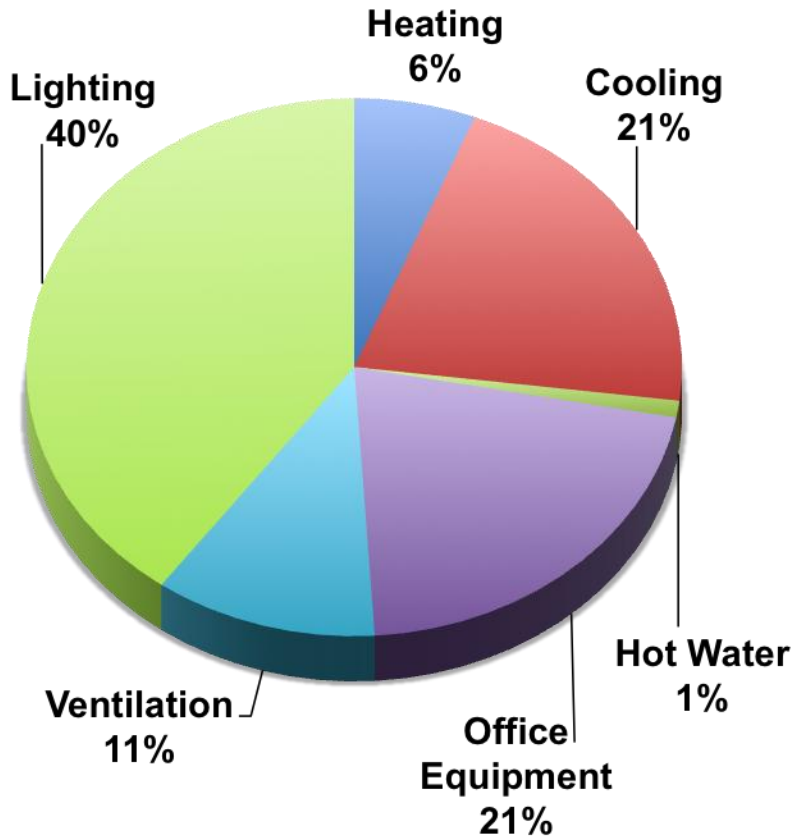


Energy Codes and Governmental Incentive Programs are encouraging the use of façade-based PV generation over the use of other key load-avoidance design techniques and technologies.

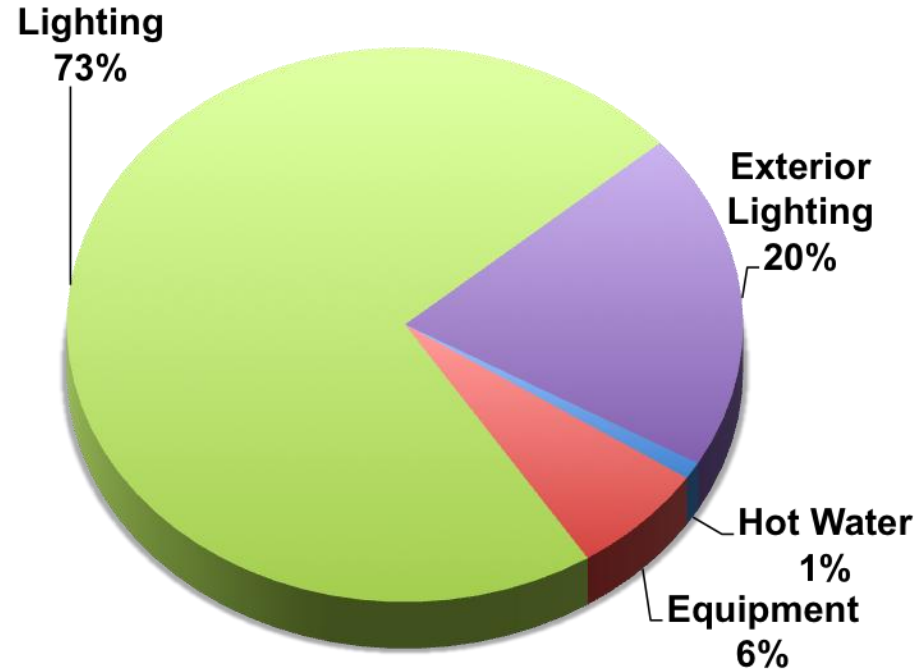
- Architects find themselves with Energy-efficiency technologies that are seemingly at odds with each other.
- Energy Code and Incentive Programs are causing Envelope-based PV Systems and Daylighting Fenestration Systems to compete for building surface real estate.

Annual % Energy Costs

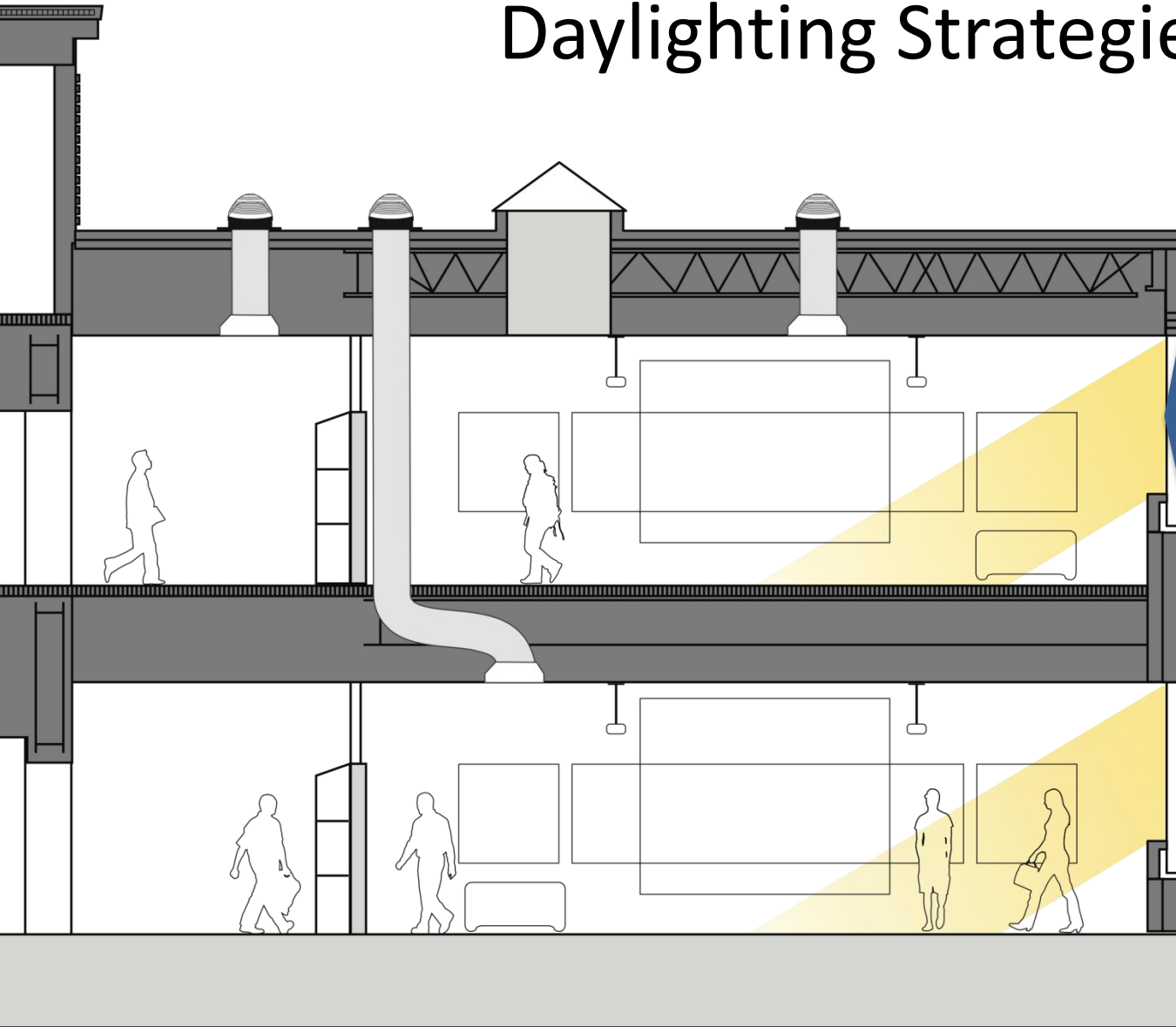
Office



Unconditioned Warehouse



Daylighting Strategies



Side Lighting (Windows)

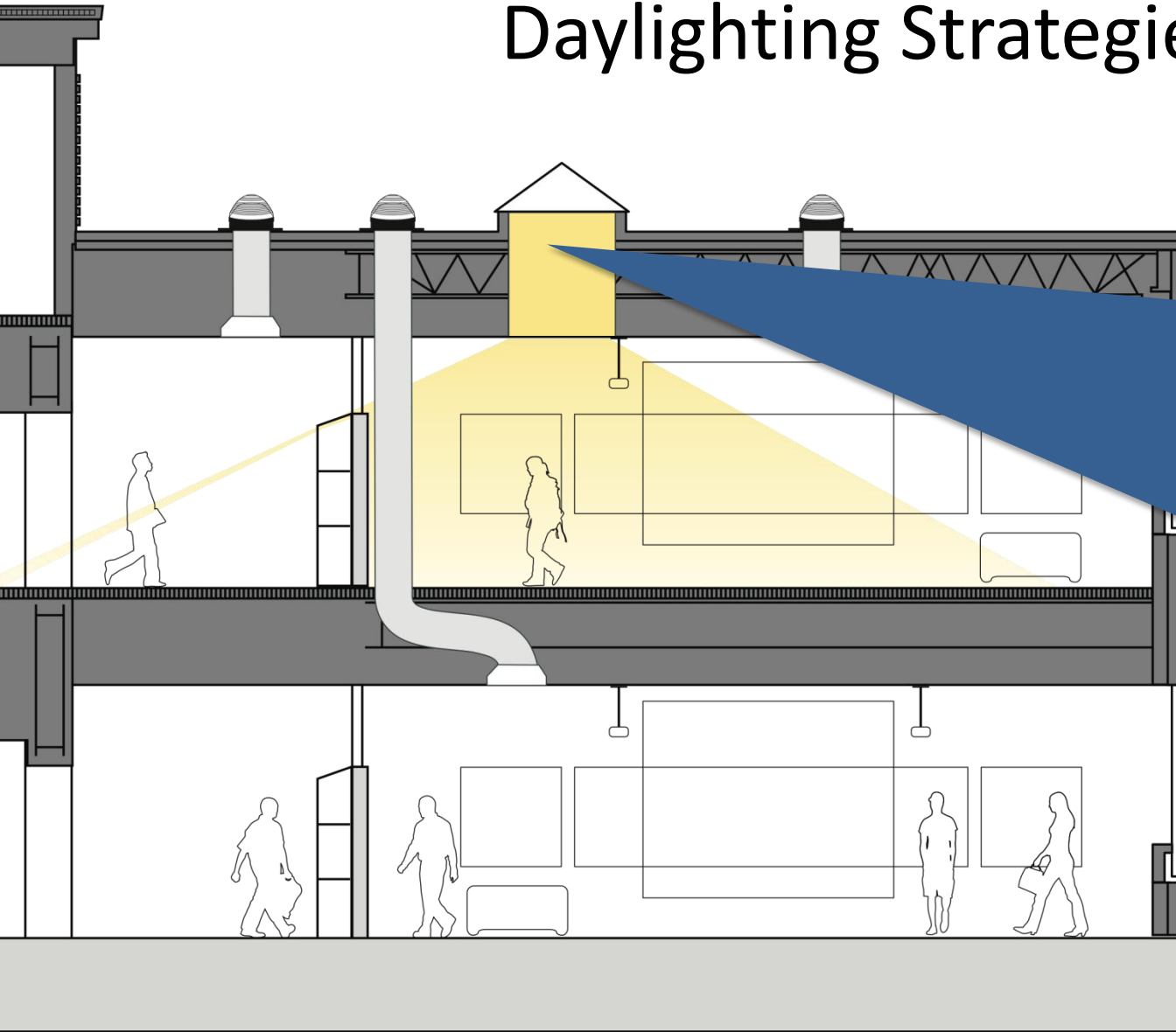
Benefits:

- View of the World
- Design Feature
- Reduce Electrical Lighting

Limitations:

- Orientation Dependent
- Perimeter Limitation
- Shifting Light Patterns
- Glare
- Thermal Performance

Daylighting Strategies



Top Lighting (Traditional Skylights)

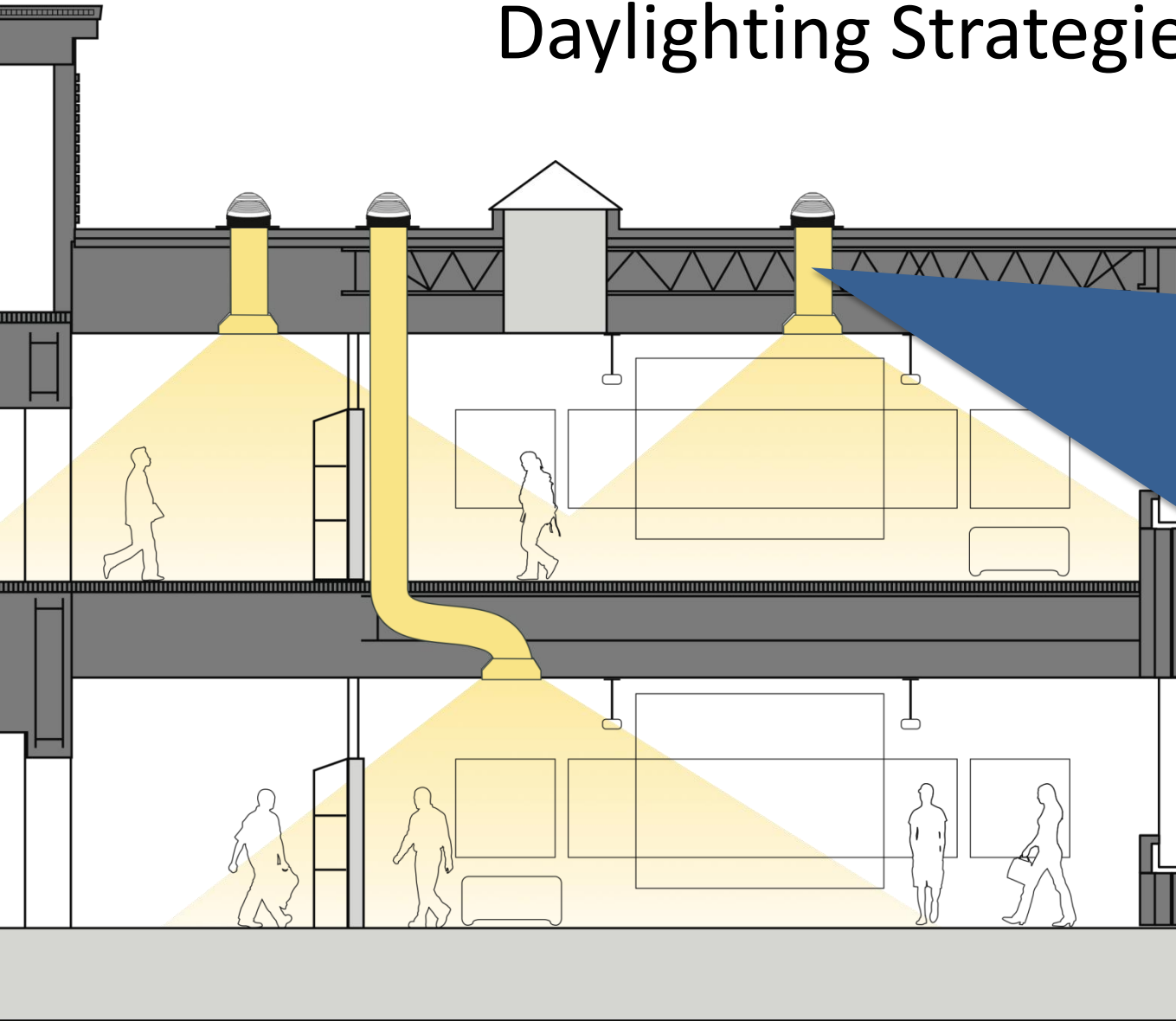
Benefits:

- Independent of Building Orientation
- Daylight Deeper into Building
- Reduce Electrical Lighting

Limitations:

- Roof Structure Impact
- Top Floor Limited
- Complex Architectural Integration
- Shifting Light Patterns
- Inconsistent light Levels
- Glare
- Thermal Performance

Daylighting Strategies

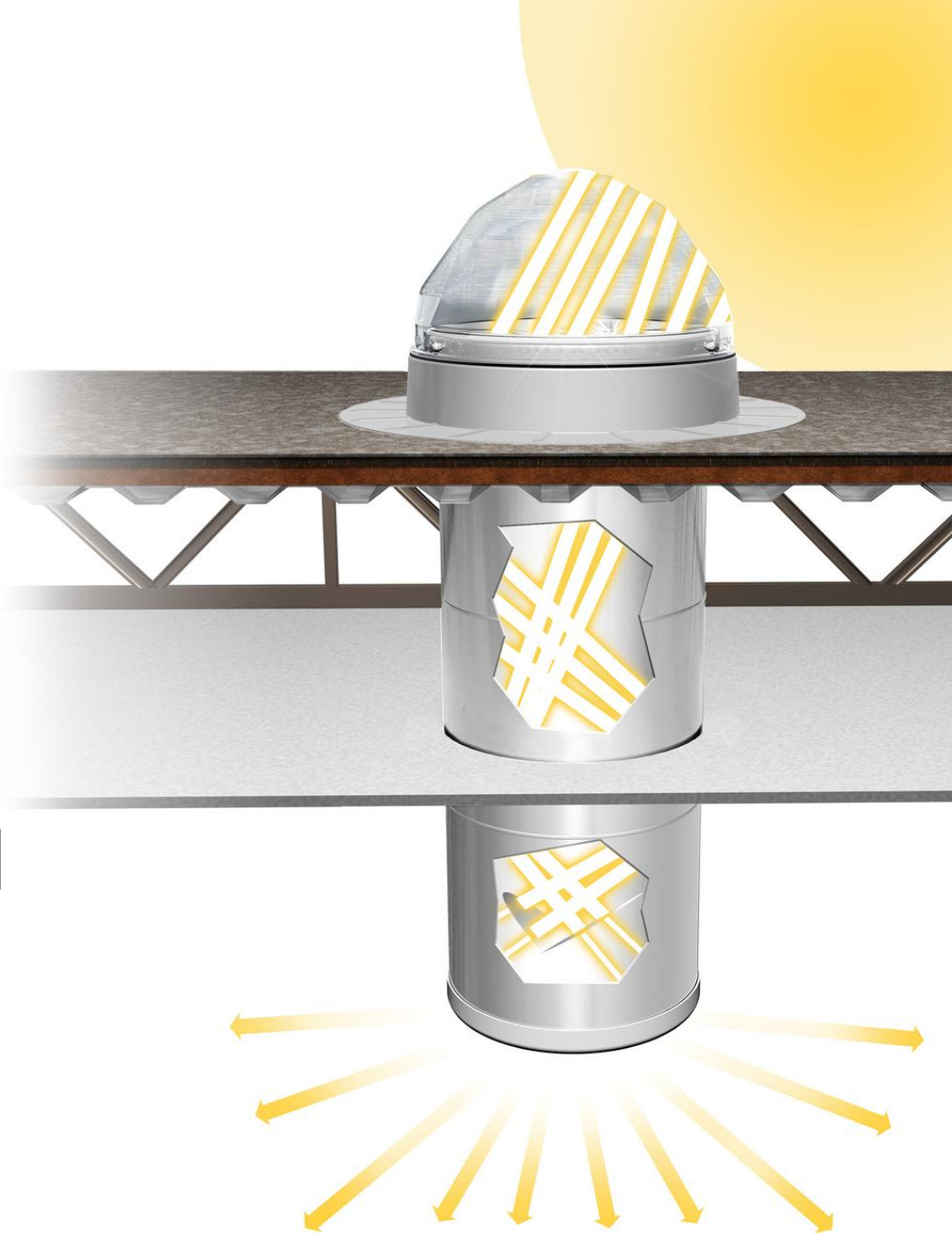


Optical Tubular Daylighting Devices (TDD's)

Benefits:

- Highly consistent and controllable
- Daylight Any Space in Nearly Any Climate
- Minimal Roof Structure Impact
- Superior Thermal Performance
- Ability to Integrate Into Building-mounted PV Modules

Advanced Optical Daylighting Systems offer breakthrough technology changes the way daylight is applied to buildings.



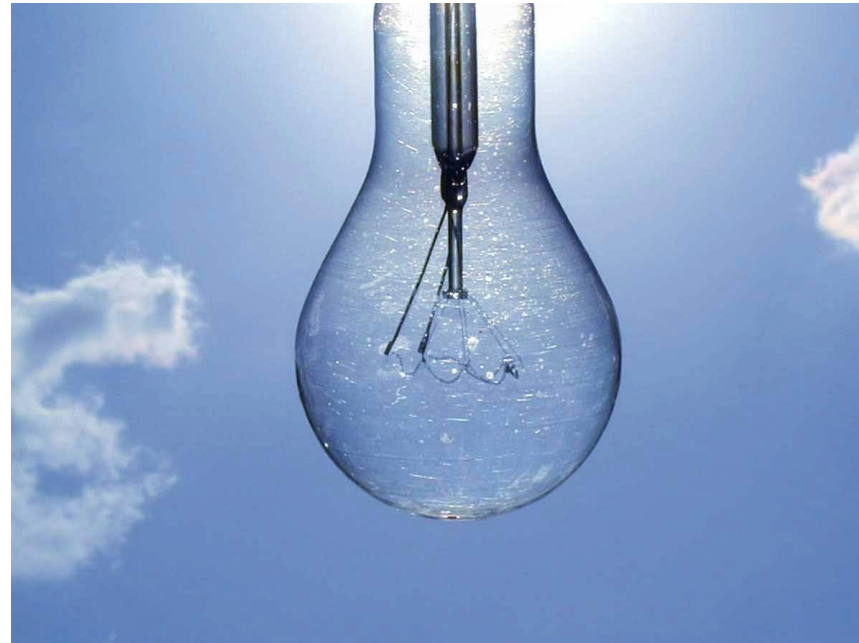
Ultra-Low Energy Buildings

- Daylighting and PV need not be mutually exclusive.
 - ✓ Benefits of Advanced Optical Daylighting Systems allow Daylight Apertures to harmonize with PV System Modules.
 - ✓ Daylight aperture locations are no longer dictated by interior space layout.



Ultra-low Energy Buildings

- The answer is a balanced, harmonious, and integrated design approach supported by enlightened code language and design guides.
- Ultra-low Energy Buildings should incorporate Advanced Optical Daylighting Technologies that maximize daily and annual daylight harvesting to minimize the need for electrical lighting.



Ultra-low Energy Buildings

- Advanced optical daylighting technologies can minimize day-time energy consumption; thus minimizing the need for site-based renewable power generation
- Investing in optical daylighting technologies to displace use of electric lighting is more cost effective than purchasing an equal amount of site-based PV power generation.

Energy Generation Comparison

Electrical Generation Source	Comparative Cost (¢/kwh)
Coal Fired Boiler	6.7
Nuclear Pressurized Water	12.0
Gas Turbine	20.8
Wind	6.8
Solar Photovoltaic	16.5
Advanced, Integrated Daylighting Solutions	5.1

Ultra-low Energy Building

Richardsville Elementary School

Warren County Board of Education

Bowling Green, Kentucky



- Net-Zero Energy Design
- 6,700 square meters
- 500 Students
- Grades: preschool-5
- High Performance School
- USGBC LEED Gold Certified

Ultra-low Energy Building



- The new building is expected to reduce energy consumption by 75% using:
 - ✓ Advanced, Integrated Daylighting Solutions (Side Lighting, Clerestory, and Advanced Optical Systems)
 - ✓ High-Performance Building Envelope
 - ✓ Geothermal HVAC System
 - ✓ Efficient Operations and Maintenance Plan
- Building Integrated PV System will supply 100% of the remaining estimated annual energy usage.

Next Steps:

Achieving Ultra-low Energy Buildings

Promoting Ultra-Low Energy Buildings Requires:

- Developing Design Guides to Share and Promote New Ideas and Knowledge
- Continue Development of “Global” Product Ratings, Test Standards, and Design Standards for All Architectural Products
- Deploy “Enlightened” Building Codes and Incentive Programs that support Integrated Design Solutions & Emerging Energy-Efficiency Technologies