


Turn off the Lights!
Energy Efficiency Opportunities through
the Integration of Daylighting
Technology

RESNET
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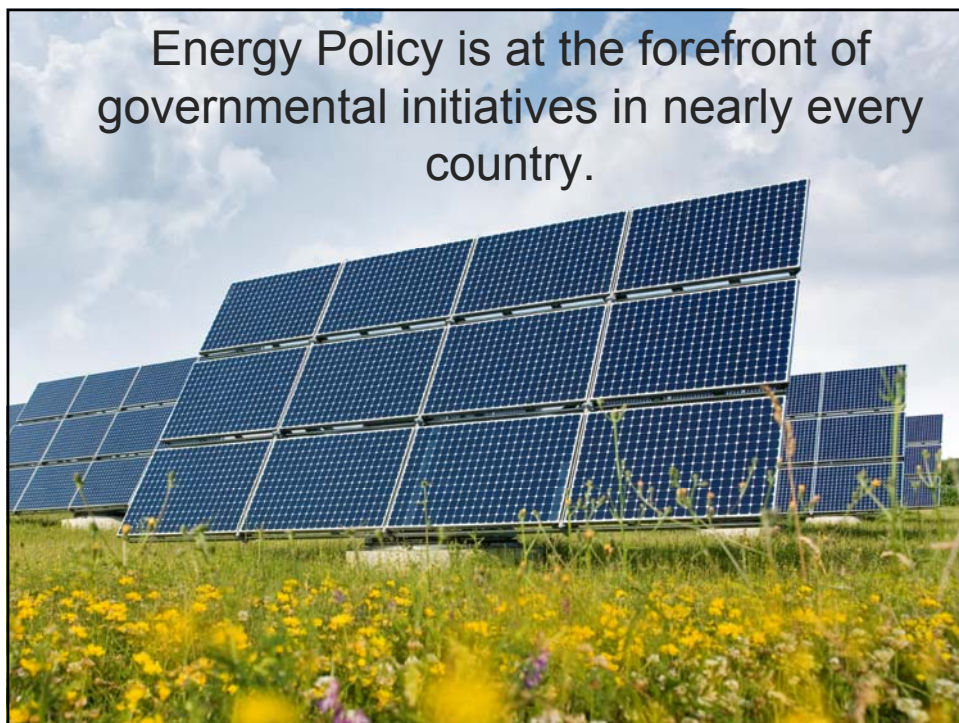


Agenda

- Role of Daylight in Residential Construction (New and Retrofit)
- New Optically Complex Fenestration Products and Residential Energy-saving Opportunities... Advanced Design Overcomes Barriers of Traditional Fenestration
- Evolution of Fenestration Metrics for Annualized Performance of Dynamic Products
- Opportunities for HERS, RESNET, and Home Energy Raters
 - ✓ Removing the “Occupant Factor”
 - ✓ Automatic, Integrated Hybrid Daylighting Systems

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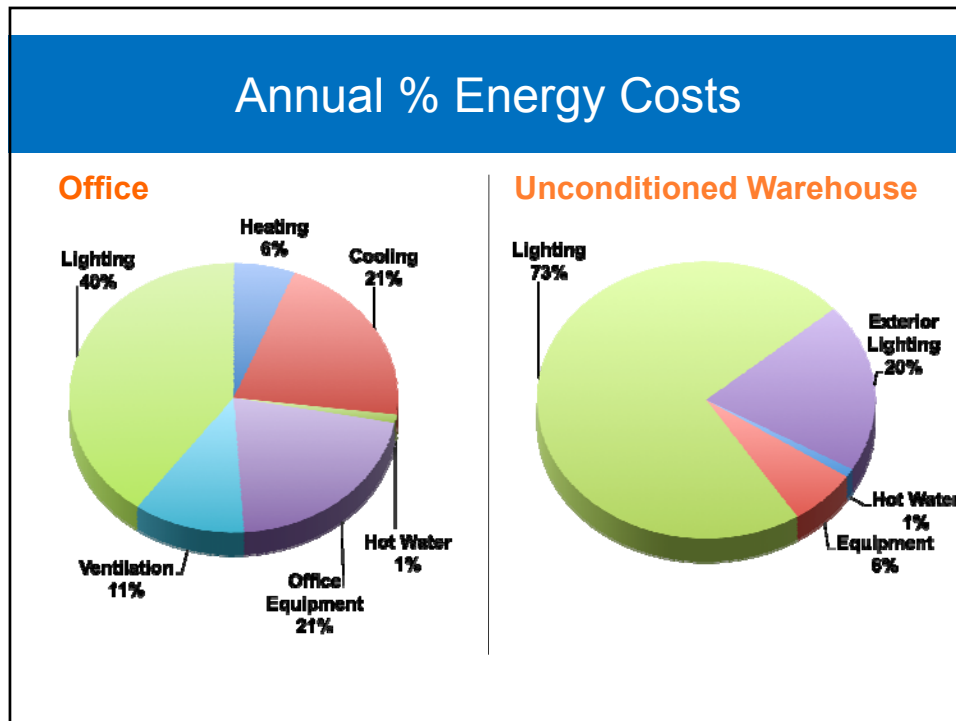


The desire to halt global warming is creating an awareness and need for sustainable buildings, communities, and societies.



The global demand for energy-efficient & alternative energy products and services has never been higher.







Daylight & Light...



- Our lives are surrounded by Daylight & Light.
- Daylight regulates our daily cycles.
 - Sleep/Wake Cycle
 - Hormone Cycles, Neurotransmitters
- Key New Terms:
 - Chrono-biology
 - Photo-biology
 - Chrono-spectral-dosage

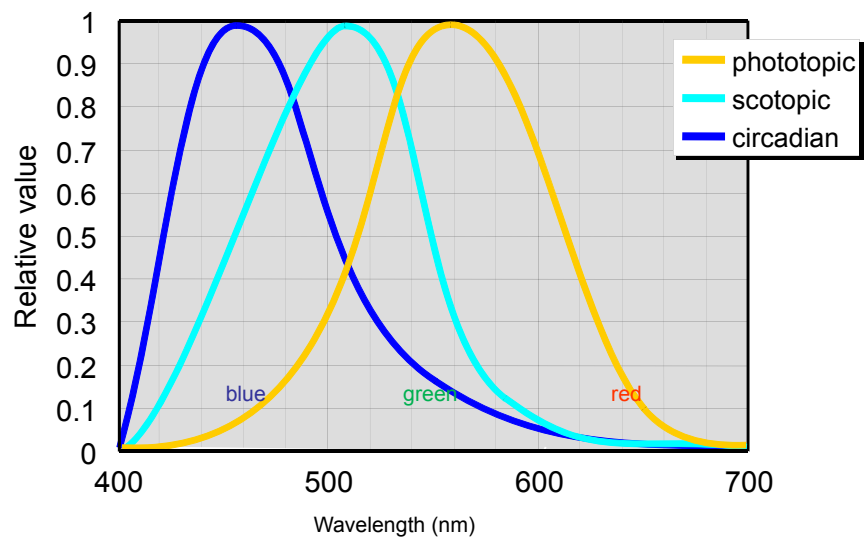
Daylight and Light



- Daylight is the Perfect Light Source – Our Reference Standard
- Provides Excellent Illumination
 - Gentle Ambient Illumination
 - Highlighting
 - Meaningful Variation (Color & Intensity Variation of Light)
- Creates Healthier Environments
 - Happier Occupants
 - Mentally Engaging Environment
- We Are Visual Animals
 - We Evolved Outdoors, Under Natural Conditions of Day and Night
 - Our Eyes and Biochemistry Reflect This
 - 80% of Our Brain is Devoted to Visual Processing
- Light (Especially Daylight) Drives Our Circadian Cycles

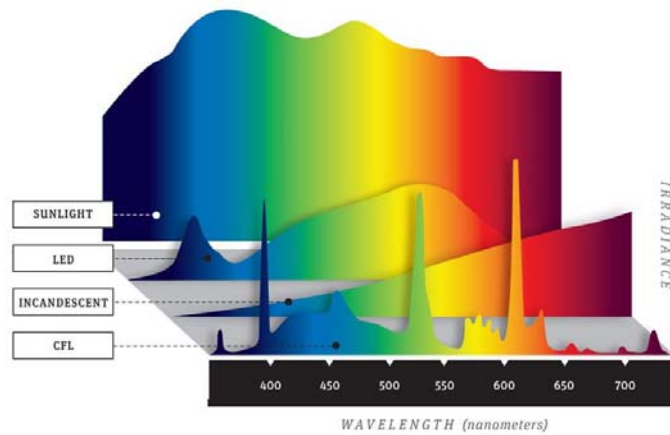
Ocular Action Spectra

How do we define the Lumen?



Spectral Power Distribution

- Spectral Power Distribution of Daylight (D55) and Other Electric Light Sources over the range of 380-760 nm. The typical definition of the Human Visible spectrum is 400-700 nm.



<http://www.popularmechanics.com/technology/gadgets/tests/incandescent-vs-compact-fluorescent-vs-led-ultimate-light-bulb-test#slide-1>

Turn off the Lights. Turn on the Sun.
Energy Savings and Carbon Offset



Residential Fenestration Influencers

- ❑ Energy Codes
 - ANSI/ASHRAE/IES 90.1
 - International Energy Conservation Code (IECC) by the International Code Council (ICC)
 - California Title 24
- ❑ Construction & Sustainability Codes and Standards
 - USGBC LEED NC 2.2/3/4 and other LEED documents
 - International Green Construction Code (IgCC) by the International Code Council (ICC)
 - NAHB Green Guidelines (National Association of Home Builders)
- ❑ Beyond-code Programs
 - ❑ Home Energy Rating System (HERS)
 - ❑ Energy Star

Energy Codes

- ❑ Energy Codes:
 - Set minimum requirements for energy-efficient design and construction for new and renovated residential and commercial buildings.
 - Establish an **energy-efficiency baseline for the building envelope, systems, and equipment.**
 - Support regular revisions that are intended to **“soften” the environmental impact of buildings through additional energy and cost savings** over the decades-long, or even centuries-long, life cycle of a building.
- ❑ Energy Codes **Do Not:**
 - Guarantee a quality, **“human-centric”** environment.

*“When looking at building design from the Energy-efficiency viewpoint, it’s all about the **energy** (heat loss, heat gain, energy consumption) and **not about the building occupants!**”*

Sustainability Codes and Standards

The general purpose of these standards are to provide minimum requirements for the **siting, design, construction, and plans for operation** of high performance, green buildings to:

- ❑ **balance** environmental responsibility, resource efficiency, occupant comfort and well-being, and community sensitivity, and
- ❑ support the goal of development that **meets the needs of the present without compromising** the ability of future generations meet their own needs.”

Lighting, Fenestration and HERS...

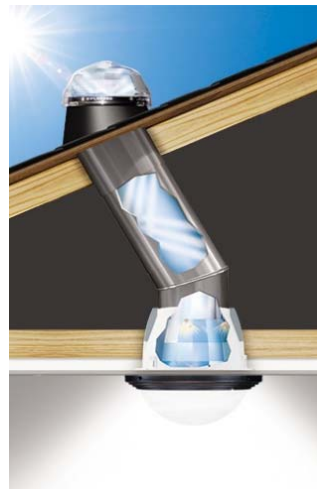
Current Practice

- ❑ Key Lighting Load Concerns
 - Occupancy Type and Schedule
 - Reduced Electric Lighting Load through Increased Lighting Efficacy
 - Reduced Lighting Loads Through Automatic Controls
- ❑ Key Fenestration Concerns (An Energy Liability)
 - Heat Loss / Heat Gain
 - Affect on Residential Loads and Annual Energy Consumption
 - Air Leakage
- ❑ Key Fenestration Factors Considered
 - Fenestration Type and Orientation
 - Size/Area
 - Static Thermal Performance Factors (U-Factor and SHGC)
- ❑ Lighting Load Reduction through Daylighting not Supported

Lighting, Fenestration and HERS...

The Future

- ❑ **New Technologies Offer Significant Opportunities**
 - **New Breed of Optically Complex Fenestration Systems Provide...**
 - ✓ Advanced Thermal Design
 - ✓ Adaptive Optics for Selective Daylight Harvesting
 - **Hybrid Daylighting Solutions Integrate...**
 - ✓ Advanced Optical Daylighting
 - ✓ High Efficacy Electric Lighting
 - ✓ Automatic Daylighting & Occupancy-based Controls
- ❑ **Predictable Lighting Energy Savings within HERS Rating Tools**



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Optically Complex Fenestration...

The Tubular Daylighting Device

Advanced Design for Harvesting Daylight

- Three Key Daylighting Component Zones
 - Capture
 - Transfer
 - Deliver + Control
- Advanced Thermal Design
 - Sealed, Multiple Insulated Glazings, & Thermally Broken System... at both Roof & Ceiling Levels



The Tubular Daylighting Device



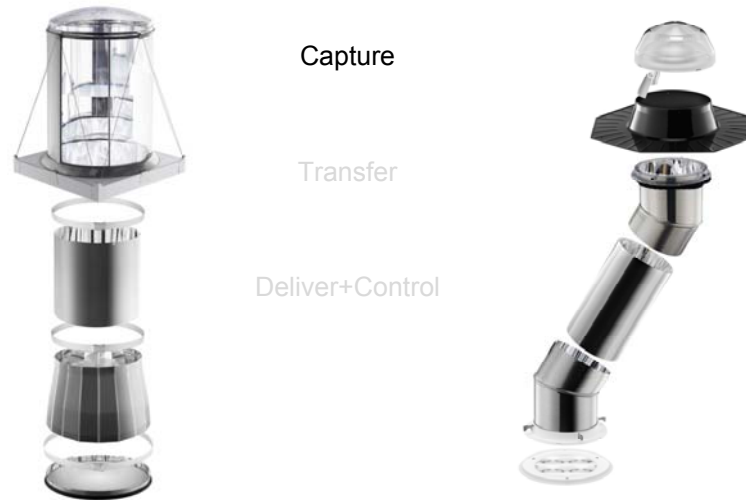
Capture

Transfer

Deliver+Control



The Tubular Daylighting Device



Capture

Advanced Optical TDD Technologies

- Angularly-selective Reflective and Refractive Dome Technologies
 - Passive optics
 - Maximizes light capture
 - Improves low angle light collection
 - Controls high angle light
 - Minimizes heat gain
- Minimal roof aperture required for effective daylighting harvesting
- Insulated, multi-glazed dome options
- Thermal breaks to minimize heat transfer





Transfer

Connecting the Roof & Ceiling Assemblies

Advanced Optical Tubing (New Factors)

Light Transfer Efficiency (LTE)

- Indicates the percentage of light that travels through the tubing daily, seasonally, and between multiple floors
- High LTE is desirable for maximizing light throughput and minimizing daily and seasonal variances in efficiency

Solar Heat Gain Coefficient (SHGC)

- IR Filtering Technologies minimize heat gain

Color Temperature Maintenance (CTM)

- Predictor of Potential Color Shift

Percentage of light delivered after 20 bounces

<small>Spectralight Infinity 99.7%</small>	<small>Enhanced Silver 97%</small>	<small>Enhanced Al/Br/In 95%</small>	<small>Anodized Aluminum 94%</small>
<small>0.3% x 20 = 94.17%</small>	<small>3.0% x 20 = 54.38%</small>	<small>5.0% x 20 = 35.85%</small>	<small>16.0% x 20 = 3.06%</small>

The Tubular Daylighting Device



Deliver+Control

Advanced Optical TDD Technologies

Diffusers, Decorative Fixtures, Dimmers

- Sealed, Insulated, and thermally-broken ceiling systems for thermal and air infiltration control
- Decorative options for any décor
- Engineered lens optics for consistent distribution patterns of light
- Optional Dimming for total control



Total System Performance

Light to Solar Heat Gain Ratio (LSG)

- LSG is defined as the ratio between Visible Transmittance (VT) and Solar Heat Gain Coefficient (SHGC)
- Indicates how well a fenestration product transmits useful visible daylight while filtering out unwanted solar heat
- The higher the LSG value, the more efficient the system is at delivering daylight and minimizing unwanted heat
- Advanced TDD Daylighting Systems minimize Solar Heat Gain through a combination of:
 - Optical Technologies at the top of the dome rejecting high angle sunlight (and Solar heat)
 - Thermal breaks between the flashing and optical tubing, and optical tubing to ceiling diffuser assembly
 - IR Filtering Tube Technology
 - Spectrally selective tubing that reflects visible light but extracts IR energy
 - Minimizes transfer of Infrared wavelengths (heat) to interior spaces

Total System Performance

Light to Solar Heat Gain Ratio (LSG)

Fenestration product	Visible Transmission (Vt)	Solar Heat Gain (SHGC)	Daylighting Energy Performance Ratio (Vt/SHGC)
Triple Glazed Low-e Window Clear glass, suspended low-e Heat mirror film	22%	0.16	1.38
Triple Glazed Window Clear glass, suspended low-e Heat mirror film, clear glass	63%	0.36	1.75
Double Glazed Window Clear glass, low-e glass	71%	0.49	1.45
Double Glazed Prismatic Skylight Clear outside, prism inside	71%	0.51	1.39
Advanced Tubular Daylighting Device	60%†	0.20 †	3.00

Source: NFRC Spectral Weighting Function Research Project, Draft 2.0, March 2007

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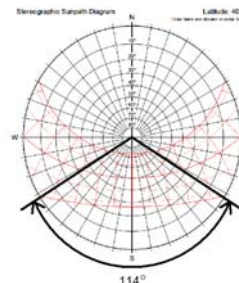
The Evolution of Fenestration Metrics!

Today’s daylighting solutions are dynamic:

- Modern Daylighting Technologies are “Smart”!
 - Complex, optically-selective fenestration systems are becoming the norm.
- Occupant comfort (not building energy) and their resulting “activity” drives annual system performance.

Single Point-in-Time and/or Single Test Condition metrics do not tell the performance story for either optically-complex fenestration OR occupant satisfaction.

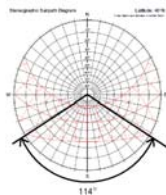
- New Dynamic Fenestration Ratings and Performance Data
 - VT_{annual} – Annual Visible Transmittance
 - Dynamic Photometry
 - Dynamic SHGC Performance Ratings



The New VT_{annual}

VT_{annual} – a meaningful, dynamic Visible Transmittance metric

- ❑ Accounts for true annual Visible Transmittance of products!
- ❑ 7 years in the making
- ❑ Rating informed by
 - 18 distinct VT data points &
 - Annual Sun Path data



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The HERS Solution

The Hybrid Daylighting System



❑ Roof Components

- Optical, insulated, multi-glazed TDD Dome Assembly

❑ Attic Components

- Sealed & Thermally-broken Optical Tubing

❑ Ceiling Components

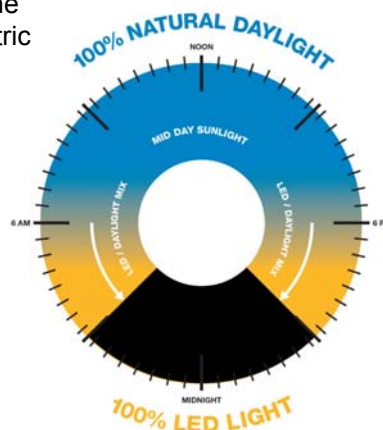
- Insulated, multi-glazed, & sealed TDD Dome Assembly
- Integrated LED emitters, Sensors, & Digital Controls

The HERS Solution

The Hybrid Daylighting System

❑ Automatic “Smart” Controls

- Removes the “Occupant Factor” by operating automatically!
- Lights the home with daylight during the day & automatically transitions to electric lighting when daylight levels are low.
- Integrated Daylight Sensor continually monitors the system ensuring that the homeowner always has the right amount of light.
- Integrated Occupancy Sensor ensures that electric light is used only when room is occupied.



The HERS Solution

The Hybrid Daylighting System

- Hybrid Luminaire – the entire bottom assembly.
 - Daylight Luminaire.
 - Driver – the component that “powers” the LED sources and “Smart” control technologies.
 - Digital Control Circuitry
 - Integrated Daylight Sensor
 - Connections for Occupancy Sensor
 - LED – Light Emitting Diode, the high-efficacy nighttime electric light source.
 - Diffuser / Decorative Fixture



The HERS Solution

The Hybrid Daylighting System

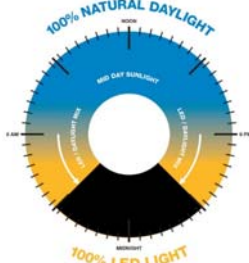
☐ Daylight Sensor

- Continually assesses daylight levels & determines when supplemental light is needed.
- Automatically triggers LEDs to provide optimal light output.
- Seamlessly transitions from waning “free” daylight to high-efficacy LED light.



The HERS Solution

The Hybrid Daylighting System



- ❑ Occupancy Sensor (Optional)
 - Detects when someone enters the lighting area.
 - If daylight is insufficient, occupancy sensor will automatically trigger the LEDs to supplement the daylight.
 - If wall switch is in the OFF position, disables LEDs from activating.

The HERS Solution

The Hybrid Daylighting System

- ❑ LED: Lighting Made to Save the Homeowner Money
 - Daytime: Lights the home using free daylight.
 - Nighttime: saving energy by using LEDs to light the room.
 - ✓ Use less energy (Maximum of 17 Watts versus 120 Watts+)
 - ✓ Typical application can provide up to a 94% energy savings!



The HERS Solution

The Hybrid Daylighting System

The 94% Energy Savings statement...



❑ Base: (2) 60W incandescent recessed can fixtures

- used 6 hrs/day (Day@3hrs, Night@3hrs)
- Energy Consumption: 120W x 6 hrs = 720 Wh



❑ Hybrid LED: (1) 17W LED with Daylight

- used 3 hrs/day
- Energy Consumption: 17W x 3 hrs = 51 Wh

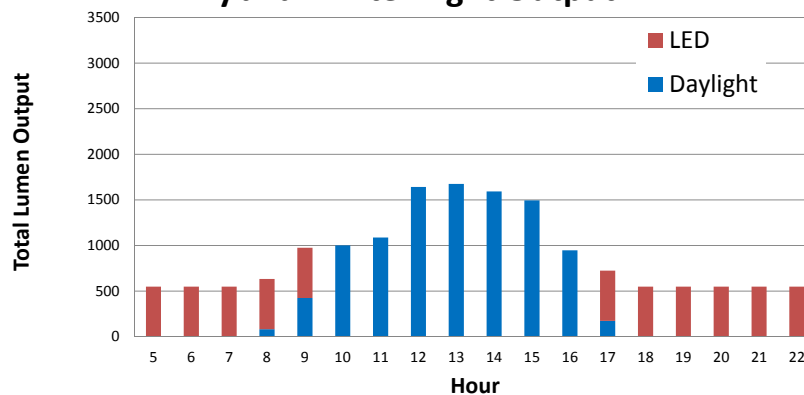
❑ Lighting Savings:

- Consumption Reduction = 720Wh – 51Wh = 669Wh
- Result: 94% Savings per Day

The HERS Solution

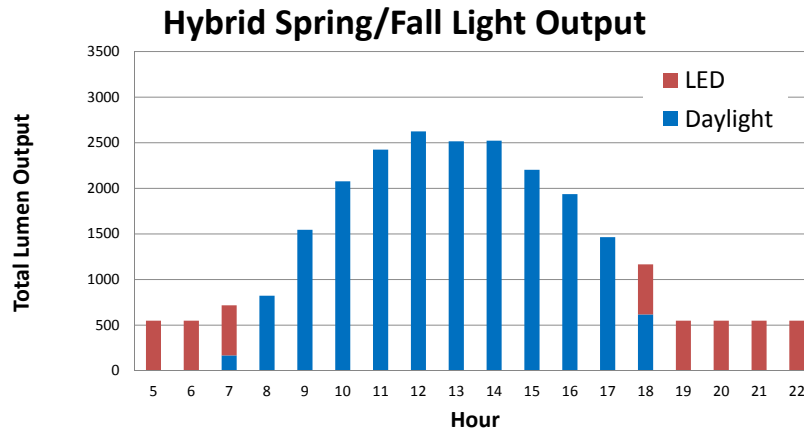
The Hybrid Daylighting System

Hybrid Winter Light Output



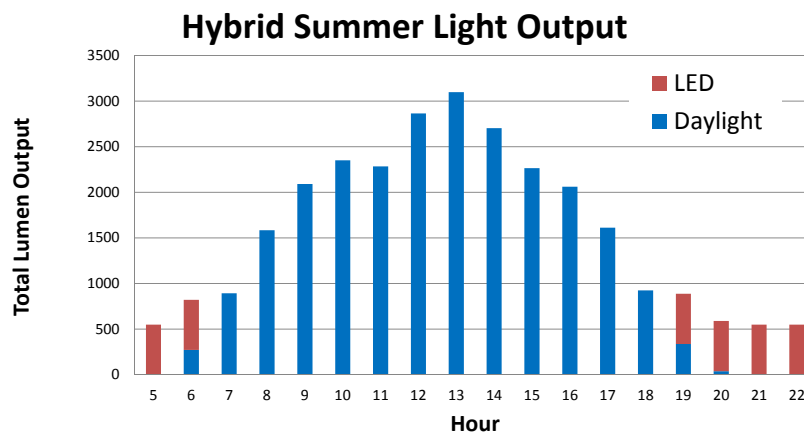
The HERS Solution

The Hybrid Daylighting System



The HERS Solution

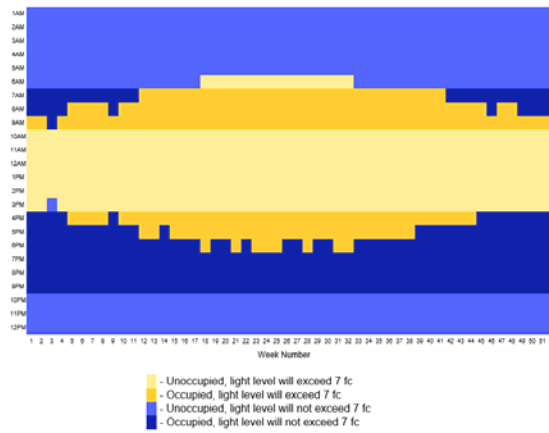
The Hybrid Daylighting System



The HERS Solution

The Hybrid Daylighting System

Sample Family Room - Annual Performance (Real Weather, Dynamic Model)



Questions?

A bright Idea for a “greener” world.
Code-compliant Sustainable design with daylight.



Achieving success is
in **your** hands!