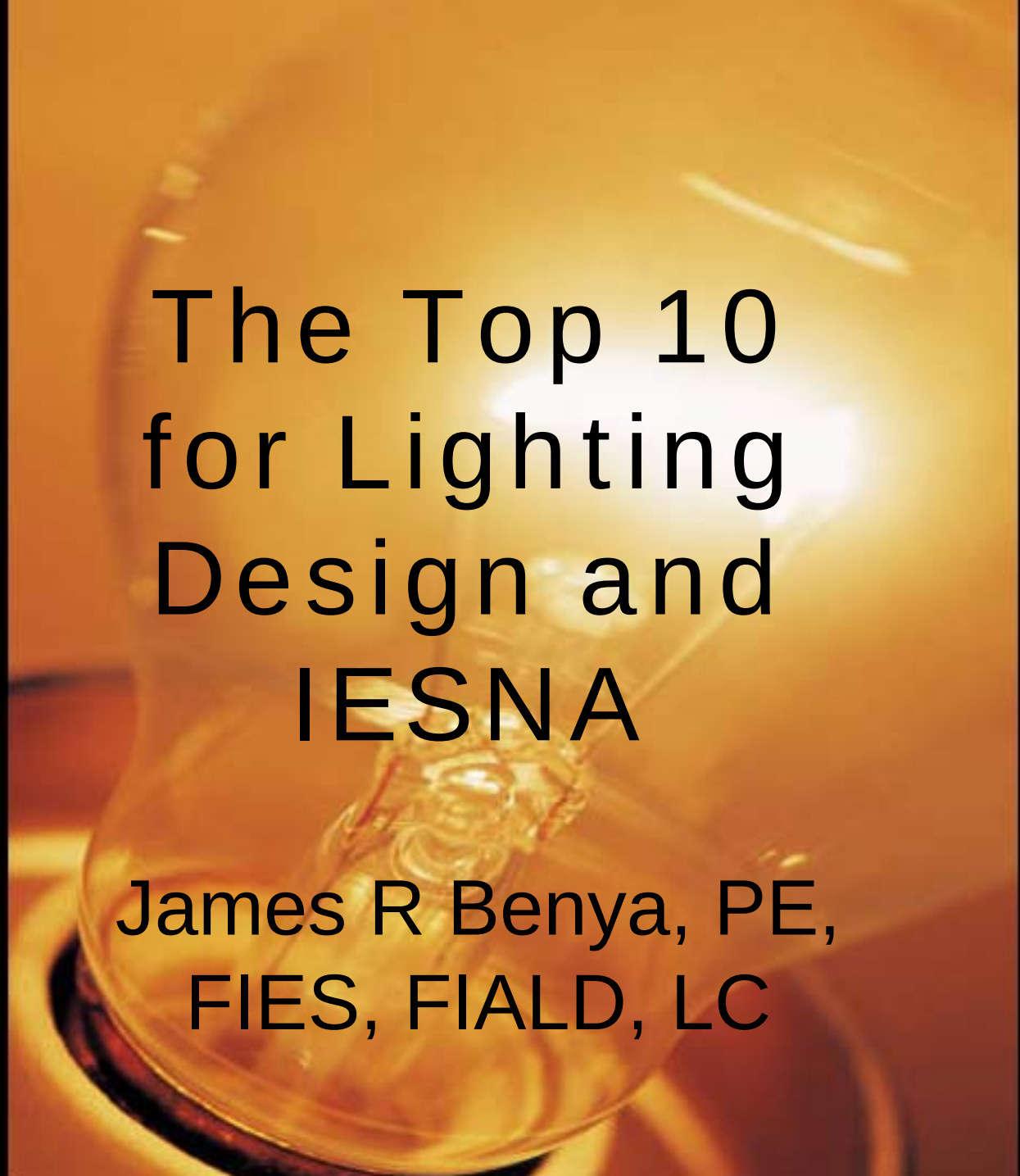


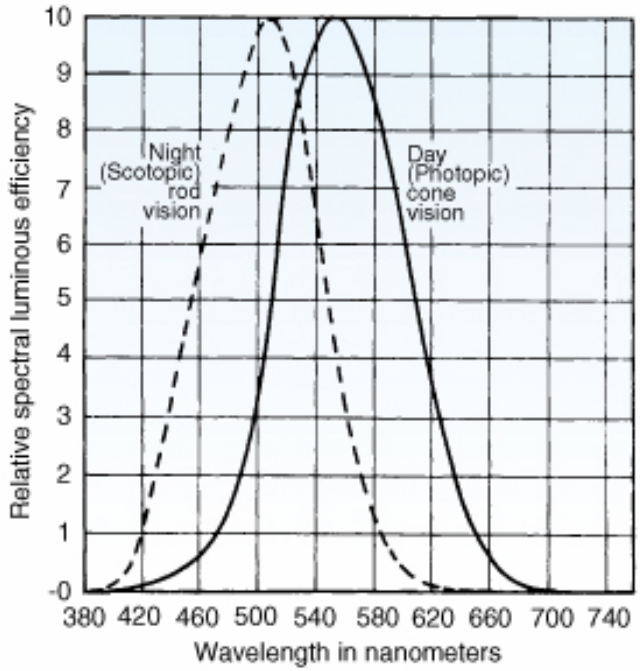
The Top 10 for Lighting Design and IESNA

James R Benya, PE, FIES, FIALD, LC

10. The Blue Light Cult

Blue Lumens

- Originated from Dr. Sam Berman
- Based on Vlamba' (scotopic vision)
- Addresses Purkinje Shift
- Issue: how does this affect vision at all levels?



9. Learning How We See

Advanced Vision Research

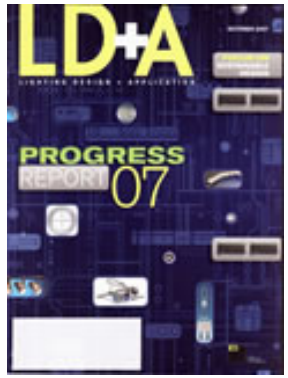
Historic

- Static
- Photopic
- Performance Based

Now Needed

- Dynamic
- Scotopic, Mesopic, Photopic
- Visibility and Performance Based
- Adaptation Included
- ETAL concepts including spacial frequency analysis

8. IESNA The Lighting Authority



Threats to Our Authority

- USGBC and CAGBC
- ICC
- Federal Governments
- State and Provincial Governments
- International Dark Sky Association

7. Returning the Night Sky

Los Angeles, 1908

Los Angeles, 1988

Opportunity

- An age of discovery
- An age of wonder
- Necessary contributions to the functionality of the built environment
- Creative contributions to the enjoyment of life

Reality

How To Fix This

- Work with International Dark Sky Association
- Develop a Model Lighting Ordinance
- Promulgate and Teach the MLO
- Make MLO compliant products

6. Lighting Education

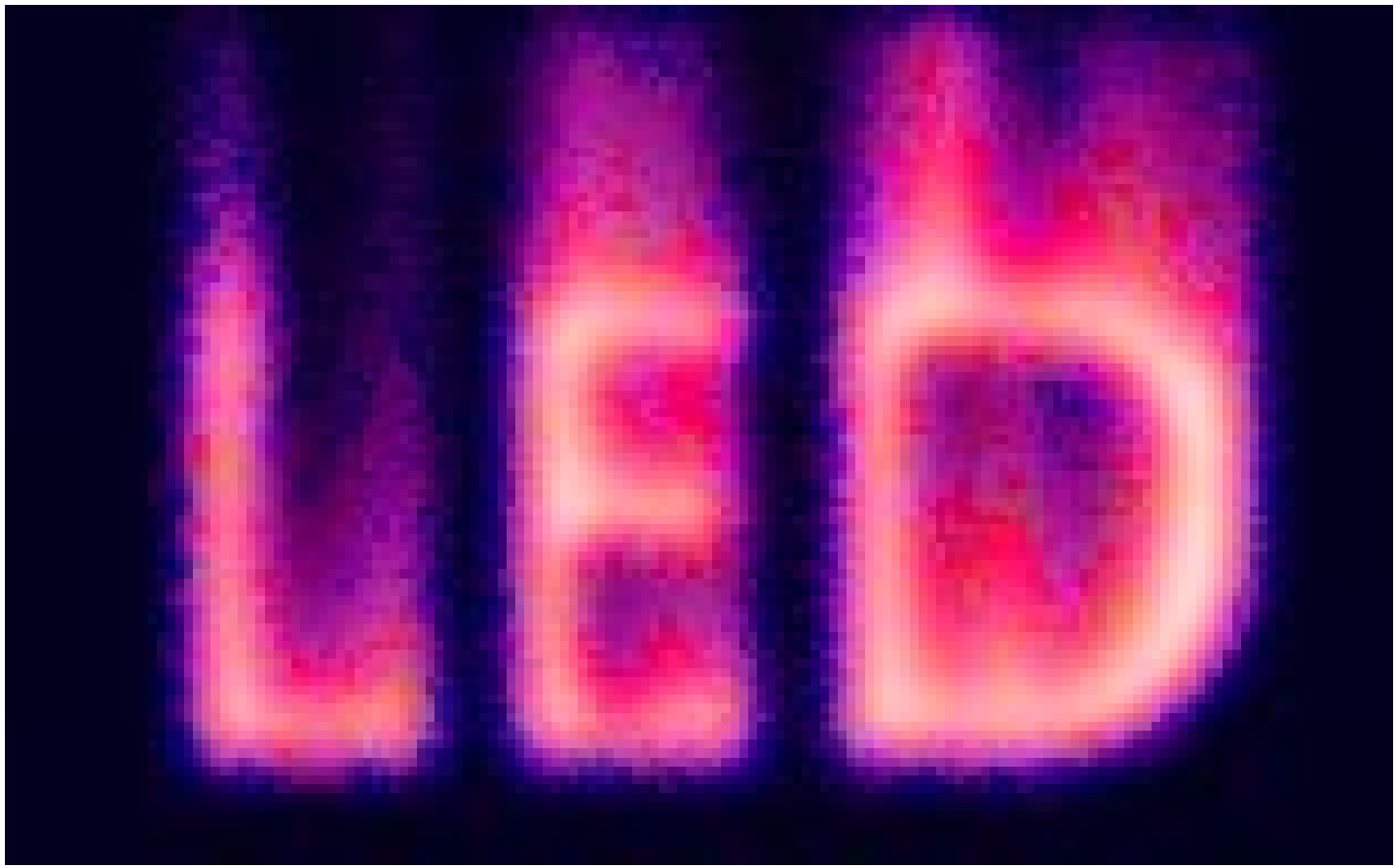
Limited Opportunities

- Less than 10 universities World Wide offering degrees in lighting
- North American Programs in Good Shape
  - Penn State
  - Parsons
- North American Programs in Trouble
  - RPI
  - Colorado
  - Nebraska
- North American Programs Gone
  - Illinois
  - New Hampshire
- Other North American Programs to Watch
  - UC Davis
- Noteworthy Changes
  - Dave DiLaura
  - Bob Davis
  - Kevin Houser

Needed: Academic Leadership and Investment

- Industry needs to invest in the colleges
- Return to existing IESNA recommendations of regional education
- FIND THE MONEY

5. The Hot Technology of our Future



Status 10/17/07

Promises

- 160 LPW
- Fabulous Color
- 100,000 hour life
- Your Dreams Come True
- Light Everything

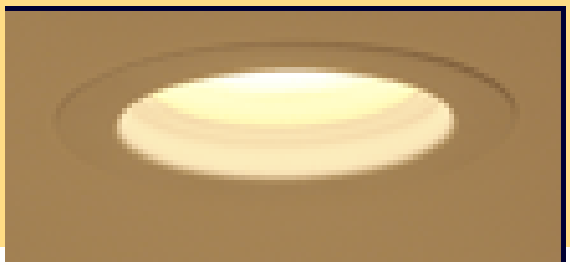
Delivered

- 50-60 MLPW
- CRI up to 92
- 50,000 hours with heat sinking
- Practical white and color applications
- Standards Evolving

Is the LED Downlight any good?

12 watt LED 6” downlight versus

a. Incandescent 65R30
b. Halogen 45PAR/IR/FL40
c. True CF 13 watt good downlight
d. Screw in CF 17 watt R40



Ratings

Lumen Output

1. True CF (900 L)
2. Halogen (800 L)
3. Incandescent (755 L)
4. Screw in CF (725 L)
5. LED (600 L)

Apparent Light

1. LED
2. Screw in CF (after warm-up)
3. Incandescent
4. True CF
5. Halogen

Ratings

Power

1. LED 12w
2. Screw in CF 15w
3. True CF 16w
4. Halogen 45w
5. Incandescent 65w

Dimming

1. Halogen
2. Incandescent
3. LED
4. True CF*
5. Screw in CF*

* *Dimming ballast*

Ratings

Glare Control

1. Halogen
2. True CF
3. Incandescent
4. Screw in CF
5. LED

Life (hours)

1. LED** (>20K)
2. True CF (10K)
3. Screw in CF (8K)
4. Halogen (4K)
5. Incandescent (2K)

**unproven

Ratings

Color

1. Halogen
2. Incandescent
3. LED
4. True CF
5. Screw in CF

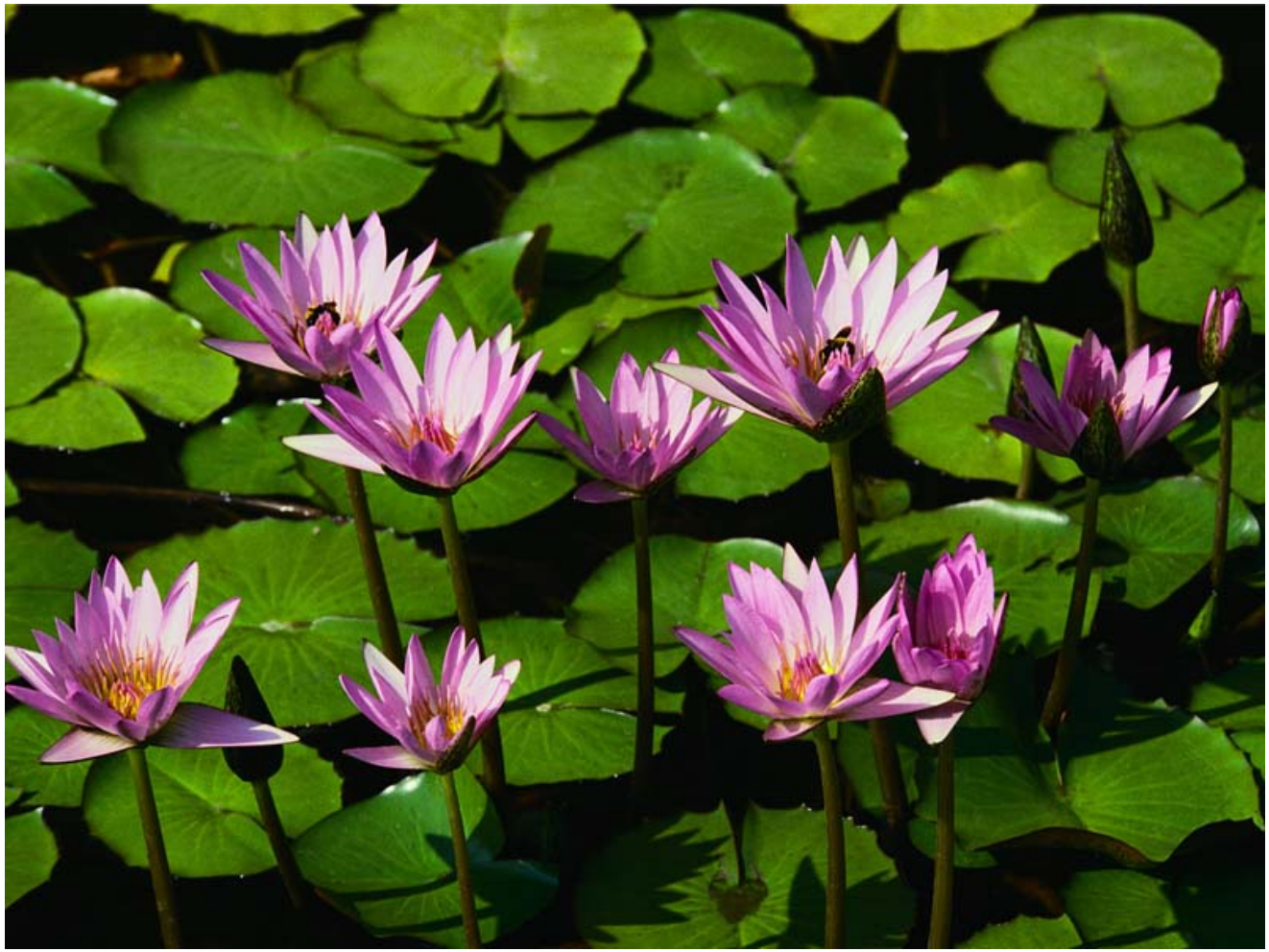
Cost (downlight)

1. Incandescent $20
2. Halogen $25
3. Dimmable Screw in CF $35
4. Dimmable LED $75-100?
5. Dimmable True CF $100

A promising future 4” product

- Adds glare control
- Improves appearance
- 600 lumens 12 watts 2700K 92 CRI
- The “real” breakthrough?

4. Photobiology



Current Issues

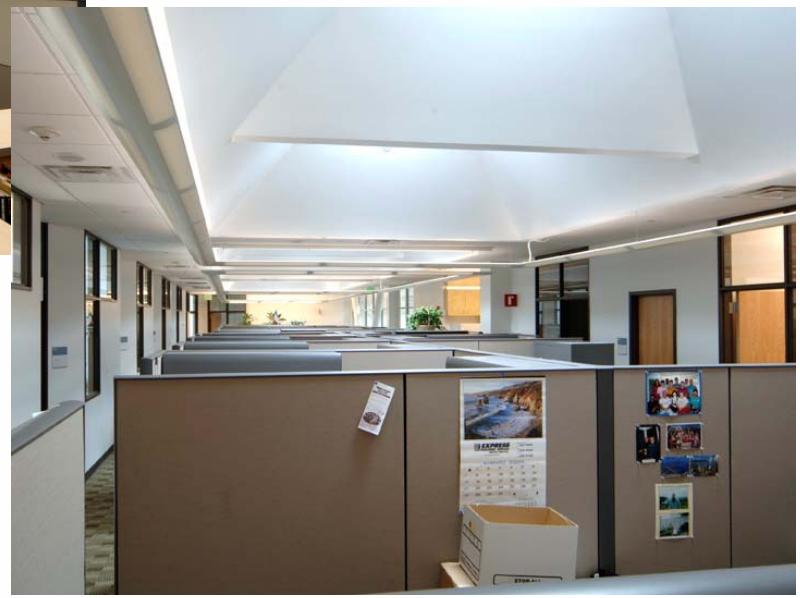
Human Benefits
- Health attributable to Circadian rhythms
  - Shift work
  - SAD
  - Senior health
- Productivity attributable to lighting and daylighting
  - Heschong Mahone Group PIER findings
  - Light Right business productivity findings
- Clinical Uses
- Vitamin D

- Impacts on other Living Creatures
  - Positive impacts (agriculture)
  - Negative impacts (sea turtles)

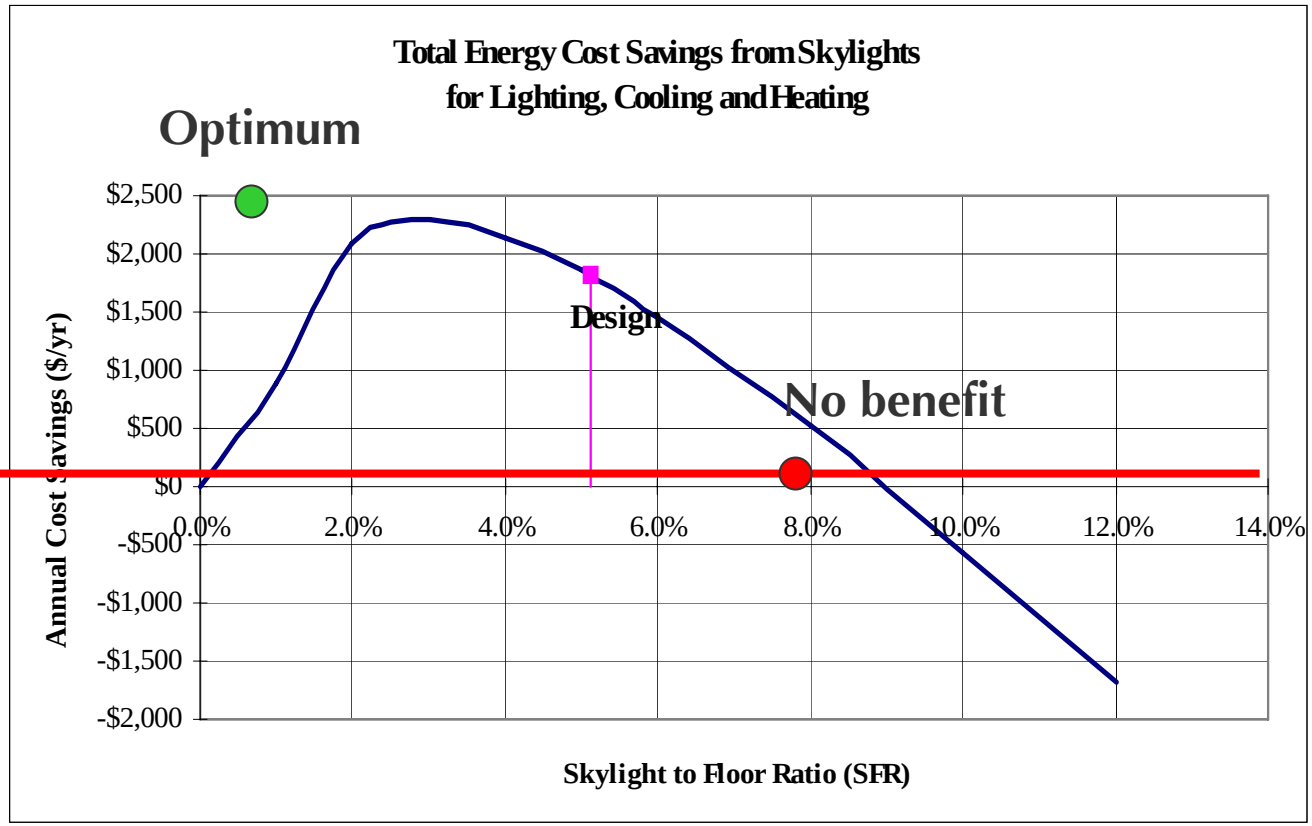
Future Issues

- Cancer related issues
- Aging Issues
- Circadian management
- Impact of outdoor lighting

3. Daylight is Lighting



Daylighting Science is Illuminating Engineering



Savings from Good Daylighting

- Up to 100% of lighting demand
- The cooling associated with lighting demand
- Excessive cooling due to sub-optimal daylighting
- Cooling energy coincident with other peaks

Critical to Good Daylighting

- Proper massing
- Proper orientation
- Proper shading
- Take advantage of topography, landscape and other natural elements

2. Sustainable Products

Using Fewer and Better Materials

Materials of tomorrow

- “Cradle to cradle” thinking
  - Recycle
  - Restore and renovate
  - Retrofit
- Good Materials
  - Low inherent energy
  - Easy recycled
  - Minimal environmental drawbacks
- Bad Materials
  - Single cycle then trash
  - High inherent energy
  - Toxic

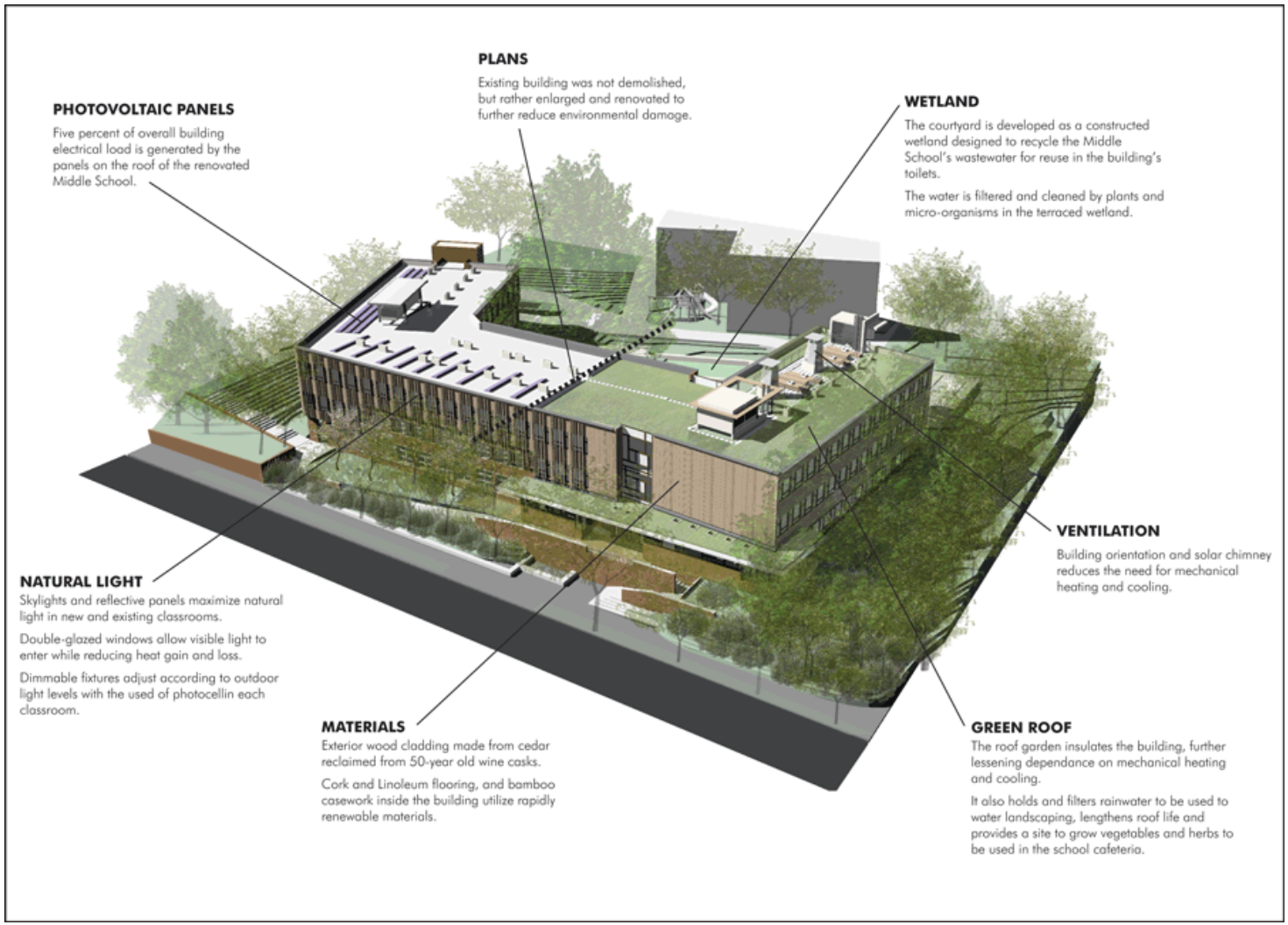
Lighting's Issues

- Heavy dependence on oil-based materials
  - Acrylic
  - Thermoplastics
- Mercury containing lamps
- PCB containing ballasts
- Electronics containing a variety of pollutants
  - Lead
  - Mercury
- Considerable by-products
  - Spent lamps
  - Short life luminaires

Sustainable Opportunities

1. Develop an energy efficient, non toxic, pollution free lighting technology and use it.
2. Carefully choose materials for products. Enhance and encourage those renewable or recyclable.
3. Minimize amount of lighting and related electrical infrastructure
   - Reduce trash and non recyclables
   - Reduce the use of copper aluminum and steel

1. Sustainable Design



Sustainable Opportunities

1. Take major steps to develop daylighting as a preferable light source.
2. Help accelerate the development and use of advanced integrated controls.
3. Work to comprehensively reduce lighting power use.
4. Develop and teach new methods for better use of energy.
5. Cease to reward blatant energy wasting applications.

Net Zero Buildings - Why Wait for 2030?

Defining “Net Zero”

- Net Zero Electricity
- Net Zero Energy
- Net Zero Carbon Footprint
- Off Grid

Almost zero lighting energy

The Sidwell Friends School
LEED Platinum
92% Lighting Energy Savings

Net Zero Electricity

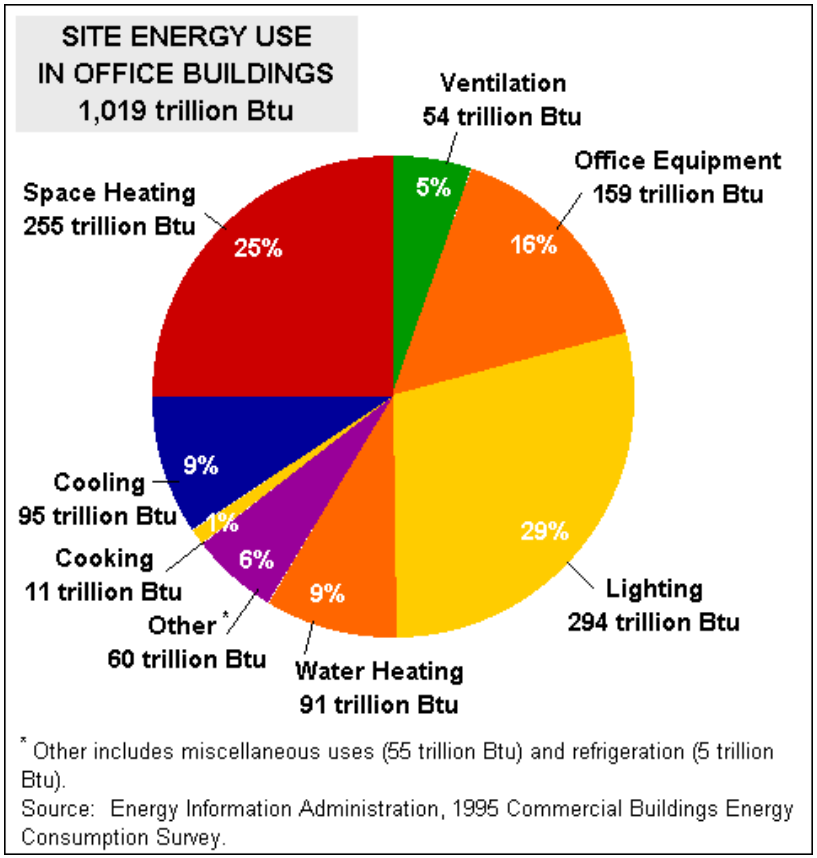
The Chartwell School, Seaside CA

- LEED Platinum
- Net Zero Electricity
- Practical Costs

Concept Behind Net Zero

- Building energy demand profile does not match non-depletable source profile
- Excess thermal energy can be stored but excess electric energy is better off returned to the grid as a “bank”
- Bank “account” is depleted periodically

Office Building Energy Use



* Other includes miscellaneous uses (55 trillion Btu) and refrigeration (5 trillion Btu).
Source: Energy Information Administration, 1995 Commercial Buildings Energy Consumption Survey.

Prime Targets for Net Zero Electricity

- Lighting
- Lighting related cooling
- Cooling due to bad daylighting
- Office Equipment

Old Energy Proverb

Negawatts cost less than Megawatts

Step 1: Significantly Better Daylighting

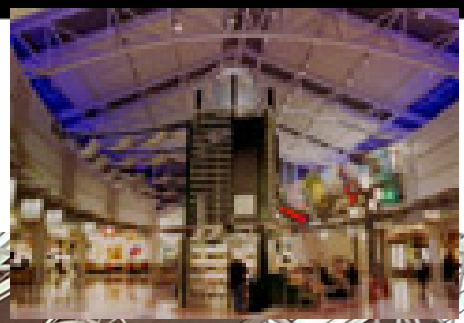
SAVE

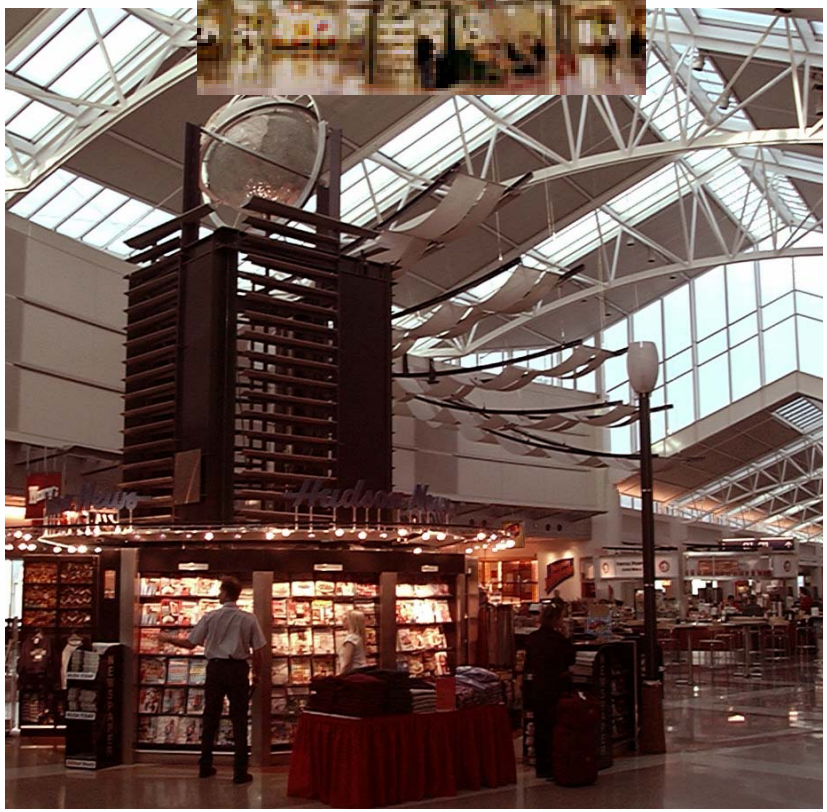
- Up to 100% of lighting demand
- The cooling associated with lighting demand
- Excessive cooling due to sub-optimal daylighting
- Cooling energy coincident with other peaks

Step 2: Better Electric Lighting

- High efficiency lighting equipment
- Smart Lights – ability to control through digital lighting infrastructure
- Natural ambient design technique – in daylighted spaces, avoid trying to produce daytime light levels with electric light
- Low ambient design
- Integrated control that assures daylight harvesting

Technique: Natural Ambient





- Takes advantage of the day-night cycle
- High light levels by day (but not too high)
- Low light levels by night (but not too low)
- Lights OFF by day – let the levels follow nature

New Technique: Natural Ambient

Step 3: Drop IT Power

2007 oPod Survey of California Offices

- Lighting 1.1 w/sf
- Computers 0.7 w/sf
- Monitors 0.4 w/sf
- Printers and misc Varies, at least 0.2 w/sf

Simple IT Changes

- Use laptops or thin clients
  - Standard office computer 60-120 watts
  - Laptop 15-50 watts
  - Thin client 10-20 watts
- Use LCD screens
- Minimize wall-warts
- Employ IT energy management software

Step 4: Control Plug Loads

Plug Loads Discovered

- Portable space heaters (10%)
  1500w
- Hot/cold water dispenser
  500 w
- Personal refrigerator (2%)
  120 w
- Personal fan (5%)
  25 w

Step 5: Mechanical and Envelope Solutions

Passive Systems such as

- Passive solar techniques
- White roof
- Better insulation
- Natural ventilation

Active Systems such as

- Hot water collectors
- Heat pumps (ground or water source)
- Dark sky systems
- Storage systems

Step 6: Load Shedding Controls

- A system to shed loads to force a better demand profile or simply prevent use at bad times
- A system to shed load in response to grid demand and/or time of use costs

Step 7: Add non-depletable source

Ordinary Efficient Building

- Lights 1.1 w/sf
- Computers 1.1 w/sf
- HVAC (cooling) 1.0 w/sf
- Plug load other .5 w/sf
- Non-process .5 w/sf

DEMAND 4.2 w/sf

Super Efficient Building

- Lights 0.2 w/sf
- Computers 0.5 w/sf
- HVAC (cooling) .5 w/sf
- Plug load other .25 w/sf
- Non-process .25 w/sf

DEMAND 1.7 w/sf

A Net Zero Building*

Envelope

- North facing triple glazed façade
- Central north facing clerestory skylight
- South facing windows with light shelf
- Skylights throughout

Mechanical

- Water source or ground source heat pump
- Natural ventilation
- Green roof with PV array
- Good insulation

*Net zero carbon on a fairly normal budget

A Net Zero Building*

Lighting

- General lighting 0.3 w/sf
- Task lighting 0.45 w/sf
- Digital dimming and controls for all systems
- Daylighting designed for >90% effectiveness

Plug Loads

- Demand response and management controls
- Workstation sensors
- >95% conversion to laptops without desktop monitor
- All LCD monitors on other computers

*Net zero carbon on a fairly normal budget

Other Keys to Success

- Totally integrated design team
- Daylighting is part of schematic design
- Owner, architect, engineers and consultants are all part of schematic design
- Early definition of goals
- Early identification of incentives and rules
- Use LEED later not now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