

James R Benya, PE, FIES, FIALD, LC
 BENYA LIGHTING DESIGN

The Costs and Benefits of Sustainable Lighting

Costs of Sustainable Lighting

More expensive?

Light Sources



- Fluorescent
- Compact fluorescent
- CFL
- Halogen IR
- MR16
- Incandescent
- LED

Light Sources

Source	Quality of Light	Flexibility of Application	Cost per million lumen hours
T8 fluorescent	Very good	Limited (linear)	\$1.19
T5 fluorescent	Very good	Limited (linear)	\$1.21
T5HO fluorescent	Very good	Limited (linear)	\$1.42
Dimming T5 or T8	Very good	Limited (linear)	\$1.49
Ceramic metal halide (70-150 watt)	Very good	Good (point source)	\$2.05
Compact fluorescent	Very good	Good (single ended)	\$2.07
Screw in CFL	Good	Very good (screw base)	\$2.33
Dimming compact fl	Very good	Good (single ended)	\$2.51
Dimming Screw in CFL	Good	Very good (screw base)	\$3.06
LED >5500K	Poor	Limited	\$3.14

Light Sources

Source	Quality of Light	Flexibility of Application	Cost per million lumen hours
LED 2700-3000K	Good	Limited	\$5.06
Halogen IR	Excellent	Good (point source)	\$5.69
Incandescent	Excellent	Excellent	\$7.42
MR16	Excellent	Very good	\$8.80
LED downlight	Very good	Downlights only	\$9.87
Ceramic metal halide (Low watts 20-39)	Very good	Good (point source)	\$10.79
Ceramic metal halide (self ballasted 25 w)	Very good	Good (point source)	\$10.82

Controls

Needed for Significant Energy Savings

Controls Strategies

- Daylighting
- Small zone motion/vacancy control
- Large zone motion/vacancy control
- User dimming
- Tuning
- Scheduling
- Adaptation Compensation
- Demand Management and Response
- Scenes and AV interface

Strategy	Costs	Included in cost	By itself saves	Works well with
Daylighting	\$1.50/sf	Dimming ballasts	\$0.25/sf/yr	Motion and manual dimming
Small zone motion	\$.50/sf		\$0.10/sf/yr	Daylighting
Large zone motion	\$0.25/sf		\$0.05/sf/yr	Daylighting
Manual dimming	\$0.75/sf	Dimming ballast	\$0.10/sf/yr	Daylighting and motion
Tuning	\$1.00/sf	Dimming ballasts	\$0.10/sf/yr	All others
Scheduling	\$0.25/sf		\$0.05/sf/yr	All others
Adaptation Compensation	\$1.00/sf	Dimming ballasts	\$0.10/sf/yr	All others
Demand management and response	\$0.50/sf	Interfaces	?????	??????
Scenes and AV	\$2.00/sf	Dimming ballasts	Varies	Varies

Strategy	Costs	Included in cost	By itself saves
Daylighting and motion	\$1.75/sf	Dimming ballasts	\$0.30/sf/yr
Daylighting, tuning and motion	\$2.00/sf	Dimming ballasts	\$0.35/sf/yr
Daylighting, dimming, tuning and motion	\$2.00/sf	Dimming ballasts	\$0.40/sf/yr
Tuning, scheduling and small zone motion	\$2.50/sf	Dimming ballast	\$0.30/sf/yr
All functions	\$2.50/sf	Dimming ballasts	\$0.50/sf/yr

Performance Capabilities of Commercial Lighting Control Systems	Daylighting	Small zone motion and Vacancy	Large zone motion and vacancy	User Dimming	Tuning	Scheduling	Adaptation Compensation	Demand management and response	Scenes and AV interface
* Performs well at modest cost ○ Performs acceptably with minor cost or performance issues X Function not possible or unusually expensive and/or difficult ? System might be capable									
State of the Art Systems									
DALI-based (stand alone) S-S	*	*	○	*	*	○	?	X	(3)
DALI-based (with overlay) S-S-S	*	*	*	*	*	*	?	*	(3)
Zone-based SSS	○	*	*	X	*	?	○	X	
Legacy-based S-S-S	○	○	*	○	(3)	*	○	○	○
Conventional Lighting Controls									
Conventional analog system with analog dimming ballasts throughout; without central relay panels S-S	○	*	X	○	X	X	X	X	○
Building Automation System (BAS) with conventional relay-based zones (2) S-S	X	○	○	X	X	*	X	X	X
BAS overlay to complex legacy system with stand alone small zones and analog dimming ballasts throughout S-S-S-S	○	*	*	*	X	*	○	○	○

Regulatory Framework

Tangible Benefits

US Regulatory Framework

Construction Codes and Standards

- National Electric Code
- UL Listing Standards

Sustainability Codes and Standards

- LEED NC 2.2 and other LEED documents
- ASHRAE/IES/USGBC 18g

Federal energy policy

EPACT and EISA

EPACT 2005

- New ballast efficiency standards
- Other product efficiency standards
- Set criteria for up to 2.25¢ per SF tax deduction for efficient buildings (recent extension to 2013)

EPACT 2005 Incentives

- Tax deduction of \$0.60 per SF for lighting systems that are 40% better than 90.1-2001 and has dual level switching
- Deduction available to designers of government-owned projects such as schools

EISA 2007

- Established program to make general lighting more efficient by 2020
- Additional standards for metal halide and fluorescent lamps and ballasts
- Requirements for Federal Energy Efficiency programs at all levels

LEED

Tougher than Code



- Leadership in Energy Efficiency and Environmental Design
- Product of US Green Buildings Council
- Increasingly important on commercial and institutional projects
- Points based system

Why is LEED Important

- Has the net effect of code for many projects
- Requires compliance with energy code and in new construction, a minimum of 14% better than code
- Is more carefully checked than permit applications

Summary of LEED Considerations

- Meet LEED, meet code
- A high LEED rating may be required by the Client
- Lighting affects both almost more than any other discipline

Utility incentives

Available from many utility companies Nationwide

Incentive Programs

- Nation wide program offerings
- Several possible program types
 - Unit by unit rebate
 - Energy savings based rebate
 - Custom rebate
 - Design assistance or reward

Example: PG&E

- Existing building lighting retrofits \$0.05 for each lighting kWh saved
- Specific retrofit unit payments (next slide example)
- Savings by Design pays up to \$500,000 for a new project and \$50,000 to the design team

Example: PG&E T8/T5 Rebate

Product Code		Rebate/Unit Measure
L895	>400 Watt lamp basecase, up to 600 Watt replacement fixture	\$125.00/Fixture
L292	400 Watt lamp basecase, up to 244 Watt replacement fixture (Tier 1)	\$100.00/Fixture
L896	400 Watt lamp basecase, 245 to 360 Watt replacement fixture (Tier 2)	\$75.00/Fixture
L956	176-399 Watt lamp basecase, up to 192 Watt replacement fixture	\$75.00/Fixture
L955	101-175 Watt lamp basecase, up to 128 Watt replacement fixture	\$50.00/Fixture
L954	≤100 Watt lamp basecase, up to 64 Watt replacement fixture	\$35.00/Fixture

LAY THE GROUNDWORK

There's free money and opportunity if you

Quintuple Dipping

Design a super-efficient building (25% better than 90.1-2004 and Title 24-2005) and dip into these!

1. Easily meet code
2. Achieve high LEED rating
3. Get 60¢/sf tax deduction for someone
4. Get 25¢/sf owner incentive from PG&E
5. Get 8.3¢/sf design incentive from PG&E

Environment

Not tangible benefits (until we run out of air, water and land)

Present Day

Coal is used to produce over 70% of the electricity in the US and 83% in China.

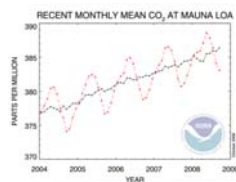
Increase in Chinese power demand adds (2) coal fired power plants per month to the grid.



Present Day

Global climate change is accelerating as greenhouse gas concentration rises faster than expected.

CO₂ concentration will soon damage ecosystems.



An international challenge



An international challenge



Sustainability is the Word



"Green is the new Black" - *NYTimes*, 2007

The Promise of Modern Lighting

- Beauty, discovery, wonder
- Necessary contributions to the functionality of the built environment
- Creative contributions to the enjoyment of life



The Reality of Modern Lighting

The Opportunity of Modern Lighting

Lighting is a prime opportunity to mitigate energy use and greenhouse gas production

- 70% of lighting energy use is by day
- 50% of lighting energy use is by older, inefficient technologies

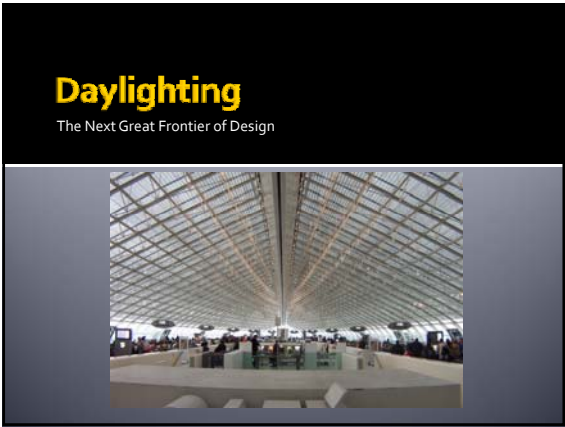
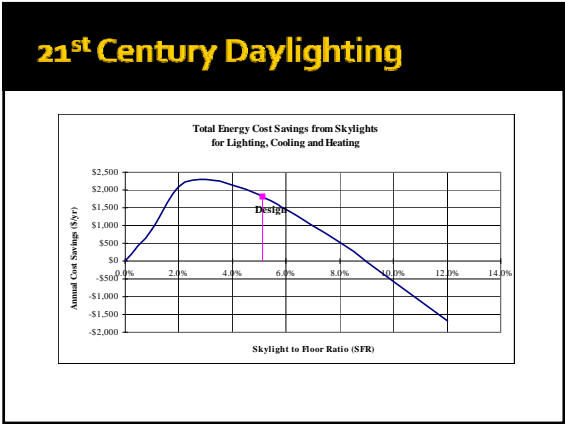
The Opportunity of Modern Lighting

Lighting is 22-25% of electric energy use in the US

- 40% commercial
- 30% industrial
- 15% residential
- 10% outdoor and signs
- 5% other

Opportunities

Less is more



Conventional Lighting

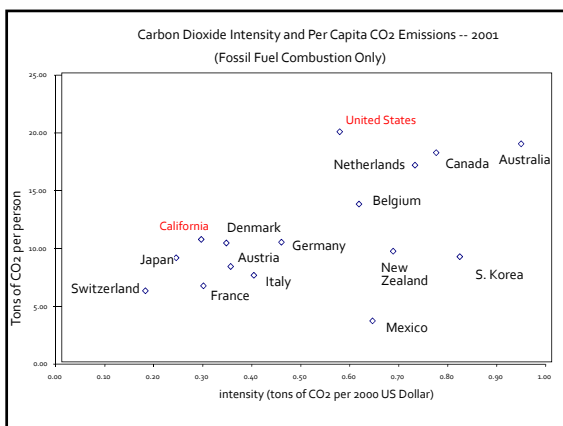
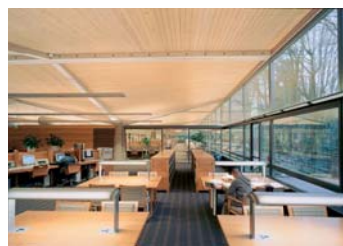
Less is more

- ## Low Power Lighting
- Low watt sources
 - LED
 - Halogen
 - Fluorescent
 - High Efficacy Sources
 - Linear fluorescent
 - High wattage HID
 - High Efficiency Sources and Luminaires
 - LED
 - Plasma HID

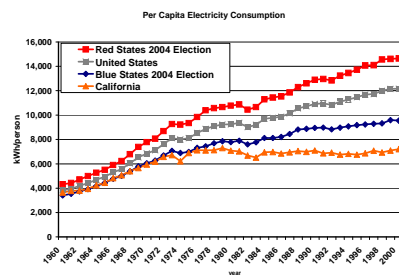
Real Time Energy Measurement

- Measure actual lighting power
- Disaggregate building energy use
 - Lighting
 - Computers
 - Transportation
 - Process
 - Food preparation
 - HVAC
 - Etc.
- Prominently Display data

Competitions Reward Sustainable Design



Retrofitting works



Reduce or Eliminate Excessive Exterior Lighting



Incentivize Better Buildings



For the Planet

- Reduce total use
- Free up peak power

For the Industry

- Good counter-cycle business
- Exciting integration of new light sources
- New opportunity to do quality lighting

Download this program at www.benyalighting.com

Thank You