Lighting NOW and in the Future

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Lighting Terms

Brief definition of lighting terms

- Light is a form of radiant energy. The visible portion of the electromagnetic spectrum that extends from 380 (violet) to 770 (red) nonometers.

- Lumens: a measure of the total quantity of visible light emitted by a source

- CCT: Correlated Color Temperature; describes the color of the emitted light. Measured in Kelvin temperature (K), on a scale of warmer (yellowish) to cooler (bluish) color. An incandescent lamp is 2700k. Standard CCTs are 2700K, 3000K, 3500K, 4100K, 5000K.

- CRI: Color Rendering Index; tells how well a source renders color on a scale of 0-100. 80 CRI is good, 90+ CRI is excellent.

CCT: Color temperatures of white light sources varying 2700K, 3000K, 3500K, and 4100K from left to right.

EFFICACY

- A measurement of efficiency in lumens/watt. Slide below is three years old.

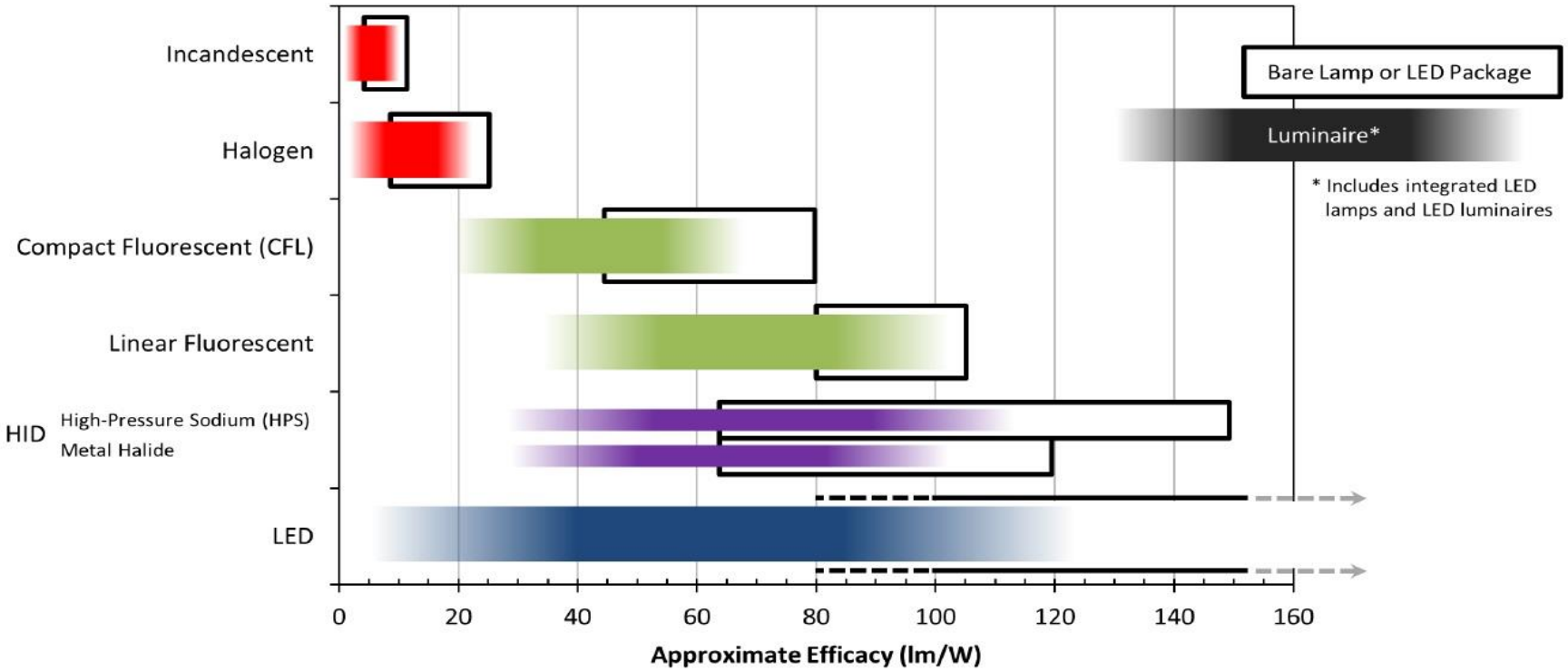
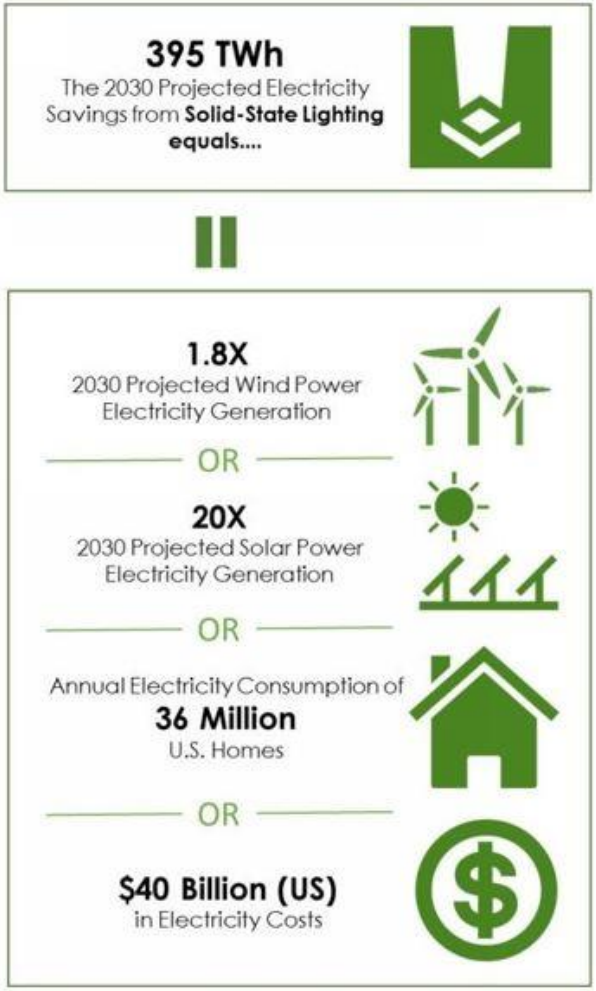


Figure 4. Approximate range of efficacy for various common light sources, as of January 2013. The black boxes show the efficacy of bare conventional lamps or LED packages, which can vary based on construction, materials, wattage, or other factors. The shaded regions show luminaire efficacy, which considers the entire system, including driver, thermal, and optical losses. Of the light source technologies listed, only LED is expected to make substantial increases in efficacy in the near future.

DOE (SSL) Program

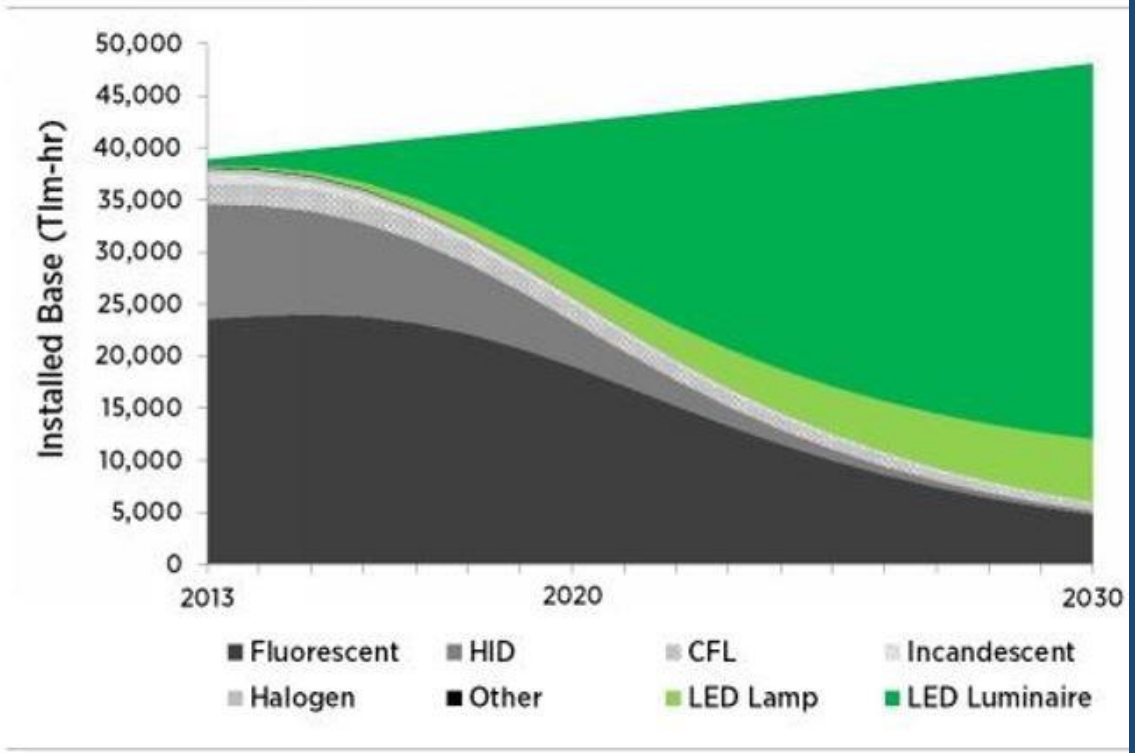
- DOE has invested with industry partners in research and development of Solid State Lighting (SSL)
- Switching to Solid State Lighting (SSL) could reduce national electricity usage by 50% by 2030.



Projected U.S. Electricity Savings from SSL in 2030 Compared to Wind Power Generation, Solar Power Generation, or U.S. Household Annual Electricity Consumption

LED Adoption

- In 2014, LED was 4% of installed base
- By 2030, LED forecasted to account for 88%



U.S. Lighting Service Forecast, 2013 to 2030

Source: DOE SSL Program, "Energy Savings Forecast of Solid-State Lighting in General Illumination Applications", August 2014 [2]

Fluorescent

- Fluorescent is still a very viable solution……
- Estimated that 30% of fluorescent tubes are T12 lamps, huge upgrade potential….
- 32W T8 standard, many other wattages available (25W, 28W)
- Typical lamp life of about 20,000 hours (mean)
- Extended Long Life T8 lamp life of 84,000 hours (mean) with Pro Start Ballast

LED Lighting (LED): A Different Animal

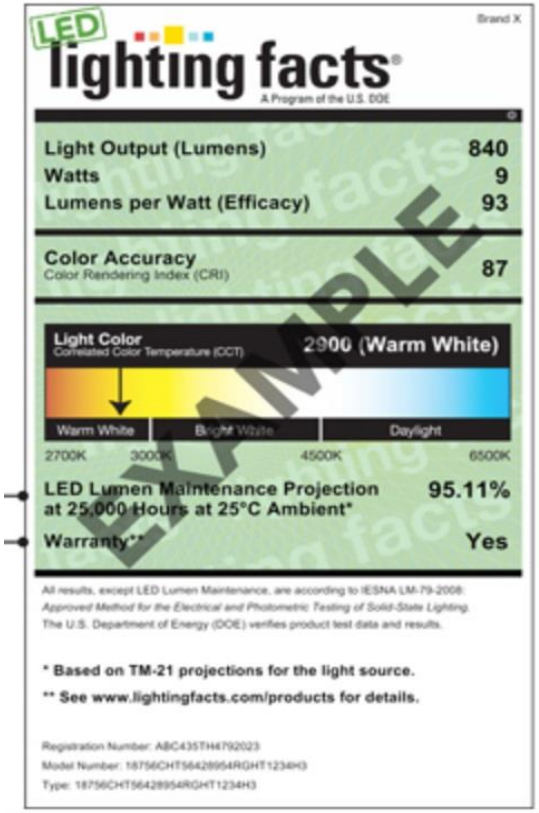
- Good Efficacy, continuing to improve
- Reduced Maintenance: life of about 50,000+ hours (LM70), never dies, just dims….good in cold climates
- LED is a Point source, less reliance on reflectors to distribute the light.
- Produces less heat, but heat is still the issue for LED life
- Color temperatures not as well standardized but 2700K, 3000K, 3500K, 4100K, 5000K usually available
- Is a cool source, phosphers used to make white light

LED Lighting (LED): A Different Animal – Continued

- Digital light source, is dimmable, and works well with occupancy sensors (carefully select dimmer)
- Get what you pay for $, be wary of false claims on internet
- No disposal issues, no mercury, dump rated
- Creative fixture design possibilities, color changing, tunable, future tech….

LED Light Fixtures

- LED Light Fixtures are UL listed as a complete assembly. This is different from previous fixtures.
- LED fixtures are tested completely assembled using "absolute photometry". Fluorescent and others use "relative photometry". LED fixture labeled with "Delivered Lumens", difficult to compare to fluorescent fixtures. Best to run lighting calcs.
- Look for UL label, Lighting Facts Label and Energy Star Label (residential).



LED Retrofit Lamps

- LED retrofit lamps are dramatic improvement over CFL lamps.
- LED bulbs : 80% energy savings compared to an incandescent bulb
- Great choices for Residential and Hospitality
- A Lamps, PAR lamps, MR16 lamps, Recess Can retrofits, Surface LED
- TLED-Direct replacement of T8 lamp in existing fixture, Not a fan of these…
- Avoid cheap LED lamps on internet, if unsure buy Cree, Phillips, GE lamps
- Look for UL label, Energy Star Label and Lighting Facts Label. LED lamps are typically labeled with comparable incandescent output, i.e. "60W Replacement Lamp"

LED Exterior Lighting

- LED great choice for exterior lighting, especially in cold climates
- Improved light distribution reduces over lighting
- Improved illuminance uniformity

Los Angeles, CA Citywide Street Light Retrofit (2008-2012)

63% energy savings, reduced light pollution

Lighting Retrofit Goals

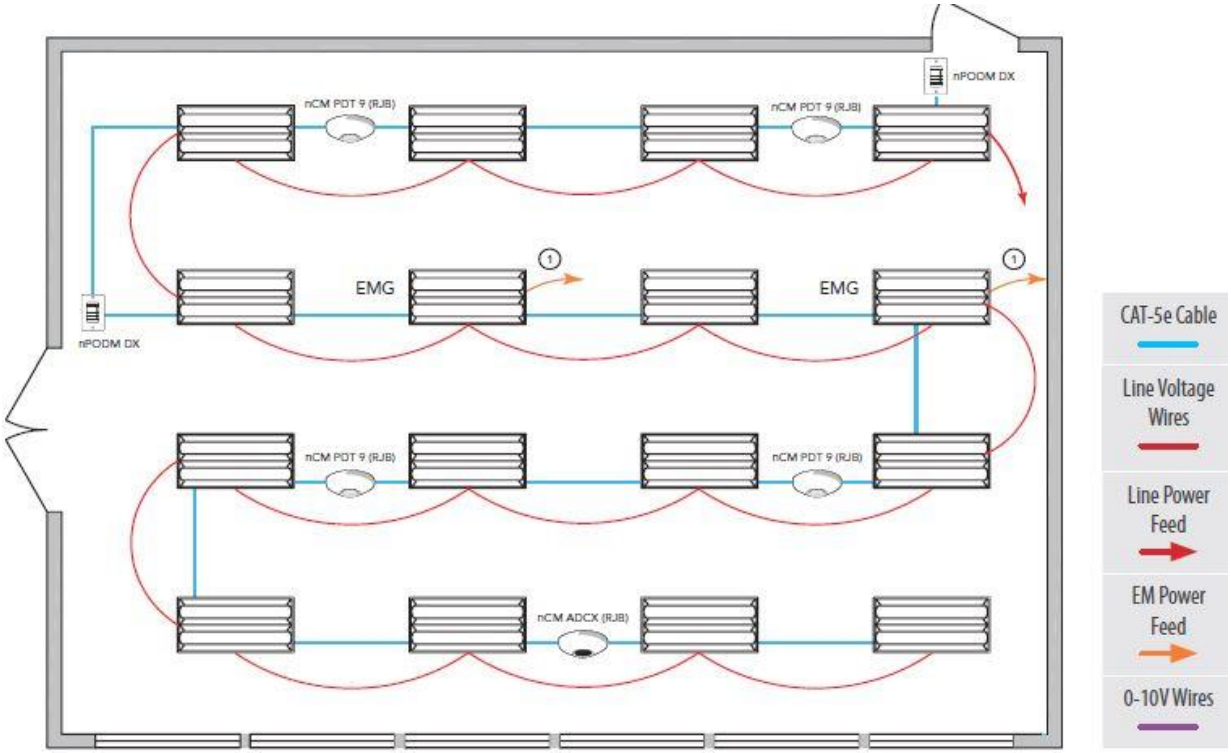
- Improve efficiency, save money $$$ with a good payback
- Reduce maintenance
- Improve the quality of lighting
  - Color Temperature (CCT)
  - CRI (color rendering index)
  - Controllability
  - Functional
  - Architectural considerations
  - Eliminate Annoyance issues: flicker, noise, glare
- Successful upgrade address ALL of these issues

Lighting Retrofit Considerations

- Understand the use of the space
- Retrofit or Replace lights?
- Vet LED Fixtures
- Consider Lighting Control Upgrades
  - Occupancy sensors
  - Dimming
  - Daylight controls
- Consider Color (CCT and CRI)
  - If color is really important, do a LED mockup (artwork, displays, etc.)
- Consider Long Term
- Put a High Value on the Quality of Light

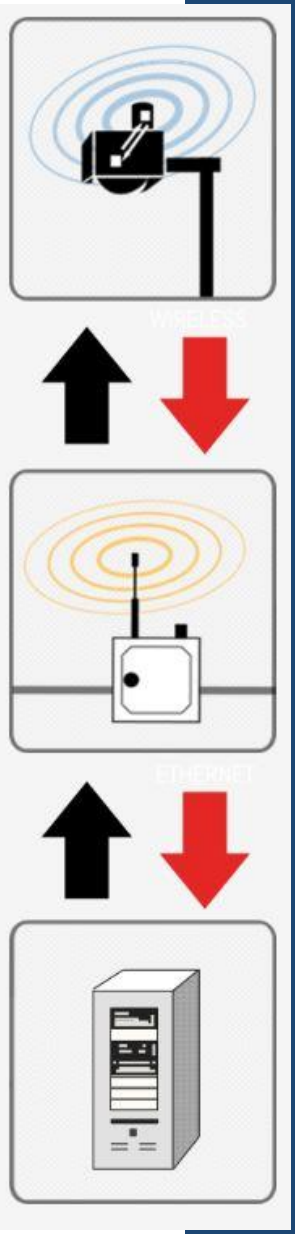
Lighting Trends and the Future

- Network Lighting Controls
  - Cat 5 control cabling, plug and play with sensors and fixtures
  - Network hubs, distributed intelligence
  - Digitally addressable, flexible design
  - Expandable in future



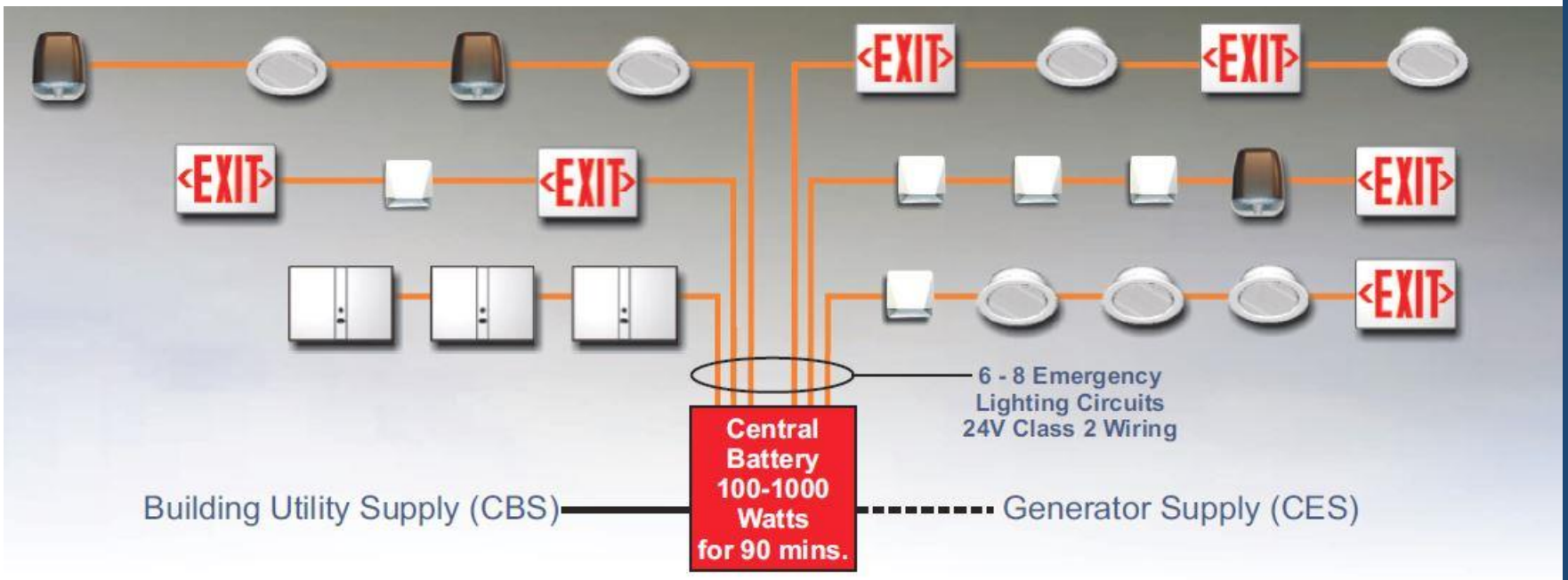
Lighting Trends and the Future

- Wireless controls (interior, exterior)
  - Wireless mesh network
  - Comm by Ethernet or cellular link
  - Monitor fixtures, control, dim, maintenance reporting
  - UAF campus exterior lights on ROAM system
  - Interior applications, remodels, hybrid system with network
  - Wireless switches, sensors
  - Good application for retrofits
- Hubbell WIHUBB
- Acuity ROAM



Lighting Trends and the Future

- LED Emergency Lighting Systems
  - Central battery cabinet
  - Optimized LED emergency and exit lights
  - Self diagnostics report to building management system, records, alerts, code compliance

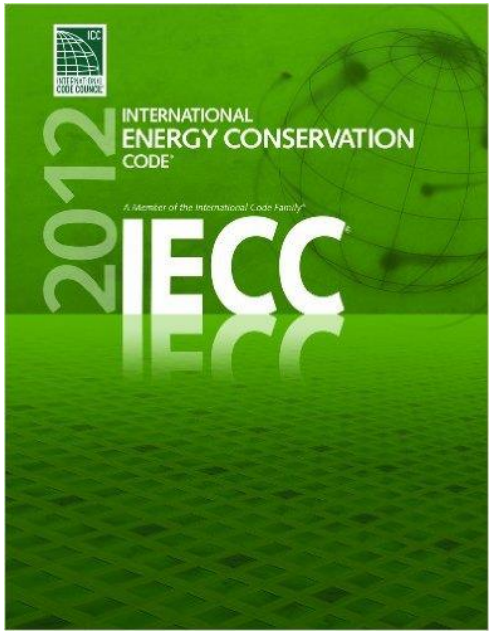


Lighting Trends and the Future

- OLED: Organic Light Emitting Diodes
  - Light emitting panels
  - Flexible and transparent
  - Color tunable
  - Still $$$ costly
  - Expected to emerge in the market within next few years

Lighting Trends and the Future

- Energy Codes: 2012 IECC, ASHRAE 90.1
  - Codes drive more prescriptive design
  - Put the light where you need it
  - Driving the use of LED and controls



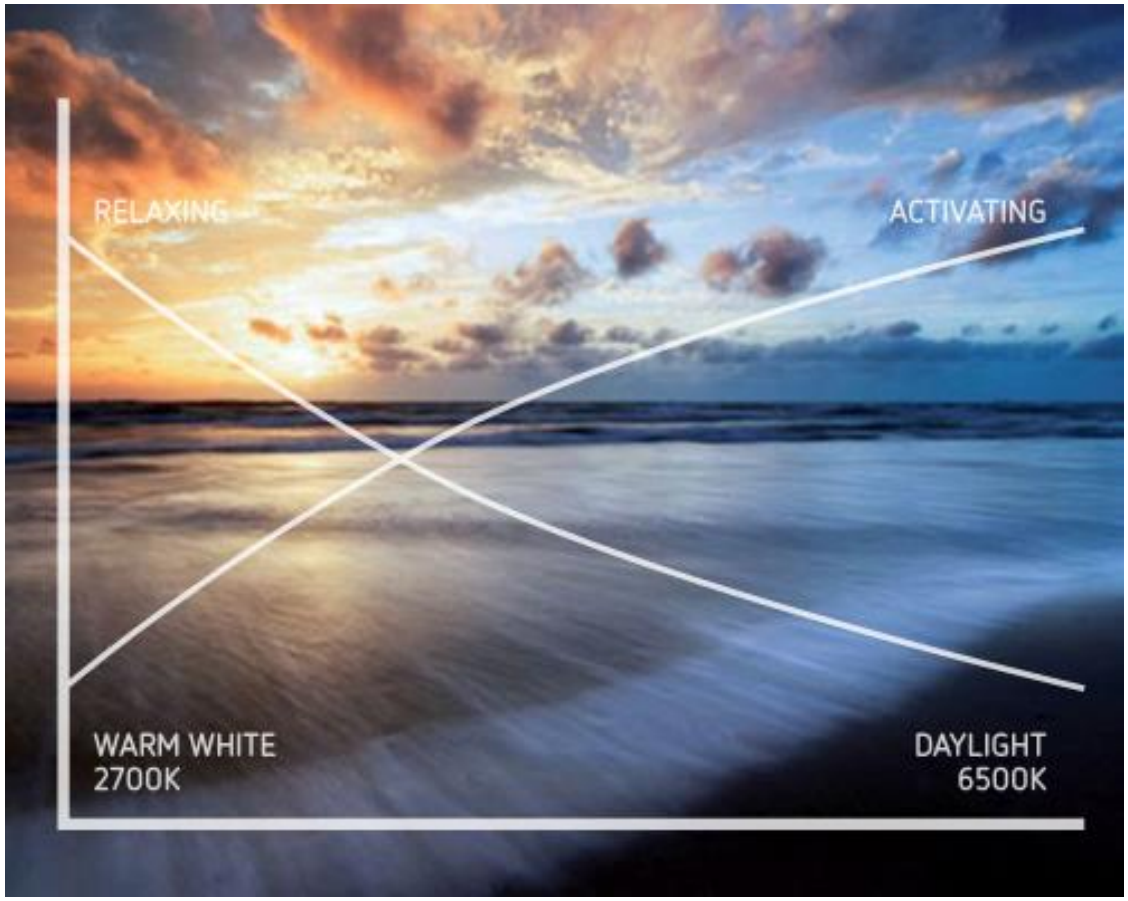
Lighting Trends and the Future

- Light and Health: Tunable White Lighting
  - Adjust CCT to match natural light changes during course of the day
  - Natural light sets the rhythm
  - Impacts on Circadian Rhythm

In nature, the light present from dawn to noon is saturated in light from the blue end of the spectrum.

In the afternoon until dusk, the blue is filtered out, leaving light that has more red saturation.

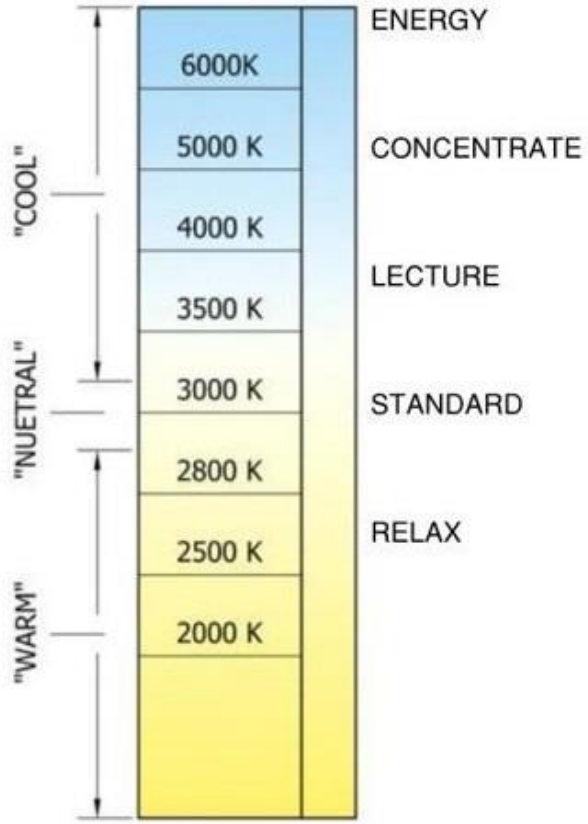
LEDs can Mimic Natural Light



The right wavelengths can have immediate effects on concentration, alertness, and acuity.

Tunable Lighting

- Schools, Hospitals, Nursing homes, Residential applications
  - Therapeutic: At a set time each morning, the lights in the space tunes to blue. The color gradually shifts to red in the afternoon. The user can manual override and control intensity.



A Resource for the Educator

A wall station can enable teachers to select the lighting mode that best serves the needs of the students.

Tunable Lighting

- Studies surrounding the use of variable lighting in classrooms show:
  - Increase in Reading Speed and Comprehension
  - Decrease in Test Errors
  - Decrease in Hyperactivity
  - Increased Efficacy in Treating Mental Disorders

- Studies surrounding the use of color control in healthcare show:
  - 20% reduction in requests for pain medication
  - 30% reduction in hospital stays
  - Greater rate of weight gain, fewer days in the NICU, faster transition to oral feedings, and enhanced motor coordination in premature infants
  - Improved sleep at night for patients where amber nightlight is present

Tunable WIFI enabled LED Lighting

- Tunable Lighting allows CCT and Color adjustment via mobile APP (residential application)
- Compatible with other WIFI enabled systems

Tunable WIFI enabled LED Lighting

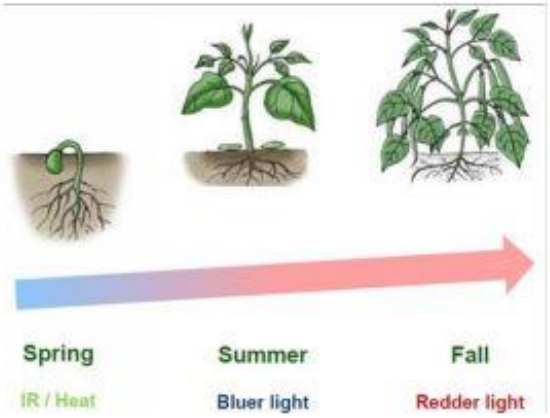
- Osram Lightify website http://osram-americas.com/en-us/lightify/Pages/default.aspx

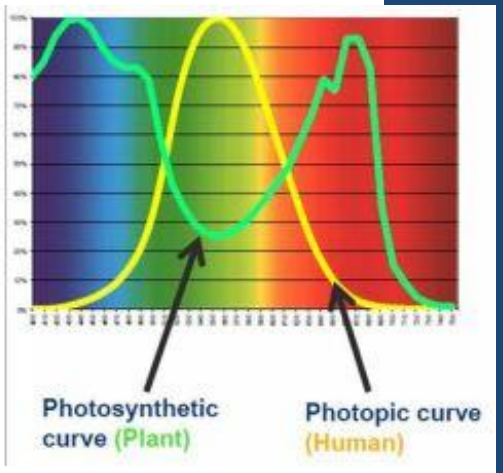
ByteLight: Location Based Services Using LED Lighting

- Marketing using combination of LED lights, cameras and smart phone

Horticultural Lighting

- Horticultural LED indoor lighting uses spectral tailoring and tuning to influence plant growth.
- Use of targeted wavelength LED lighting yielded the following results at the 2015 DOE SSL R&D workshop:
  - 100 fold production increase indoors vs. outdoors (10,000 heads lettuce per day)
  - 2.5 times faster growth compared to outdoors
  - 40% waste reduction compared to outdoors
  - 1% of water usage compared to outdoors
  - 40% reduction in power usage compared to fluorescent light





Questions?

References:

- US Department of Energy , Solid-State Lighting R&D Plan, prepared by Bardsley Consulting, SB Consulting, SSL, Inc., LED Lighting Advisors, and Navigant Consulting, Inc., May 2015
- Acuity Brands ROAM wireless outdoor lighting system
- Hubbell Control Solutions, wiHUBB wireless mesh network
- Acuity Brands nLight Network Controls
- Signtex Emergency Lighting
- Osram Sylvania Lightify tunable WIFI enabled LED

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