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sense and simplicity









A Whole New World With LEDs

LEDs 101

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Leff Electric Clean Energy Seminar & Trade Show
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LEFFELECTRIC

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The future is brighter than ever

Unleashing new possibilities with LED Lighting



Unique, fully-integrated lighting solutions enable and enhance our lives



Climate change and sustainable development…

Almost one-fifth of global electricity consumption is used for lighting

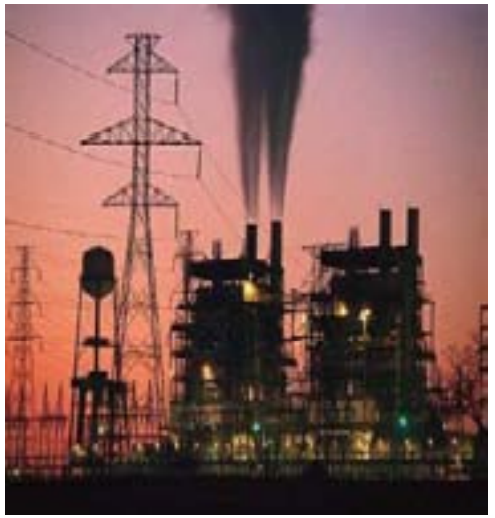


LED Lighting Opportunities

- The largest future green market is energy efficiency — not solar, wind, or biomass
- Lighting consumes 25 to 40% of all commercial energy — making lighting retrofits and upgrades a fast-growing segment
- Lighting accounts for 8% of all energy use and about 19% of all electricity use worldwide
- LED lighting could reduce lighting-related energy consumption by as much as 50%

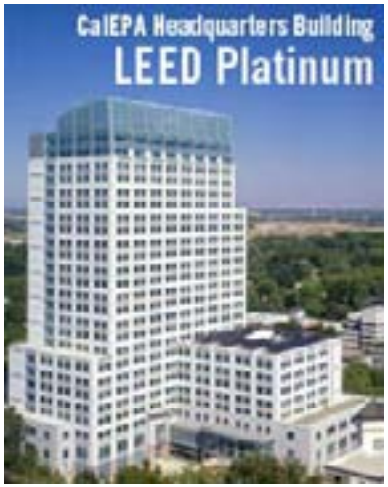


Pine Avenue, Long Beach, California
Photo: Frank Dorosy



Energy Related Activities and Trends
Encouraging SSL

- Legislation Relating to Energy
  - Energy Bill, Title 24 (CA), Las Vegas and Neon, Japan
- Incentive Programs Encouraging Energy Efficient Lighting
  - Utilities, State, Federal programs (e.g., NSTAR, PG&E and others)
- Funding Opportunities Are Being Sought
  - Energy Bill, DoE, DARPA, NYSERDA
- Standards Emergence
  - Energy Star, LEEDs, ASHRAE 90.1
  - Definitions, Color, Light output and much more



Touchstone Energy® Cooperatives
The power of human connections®

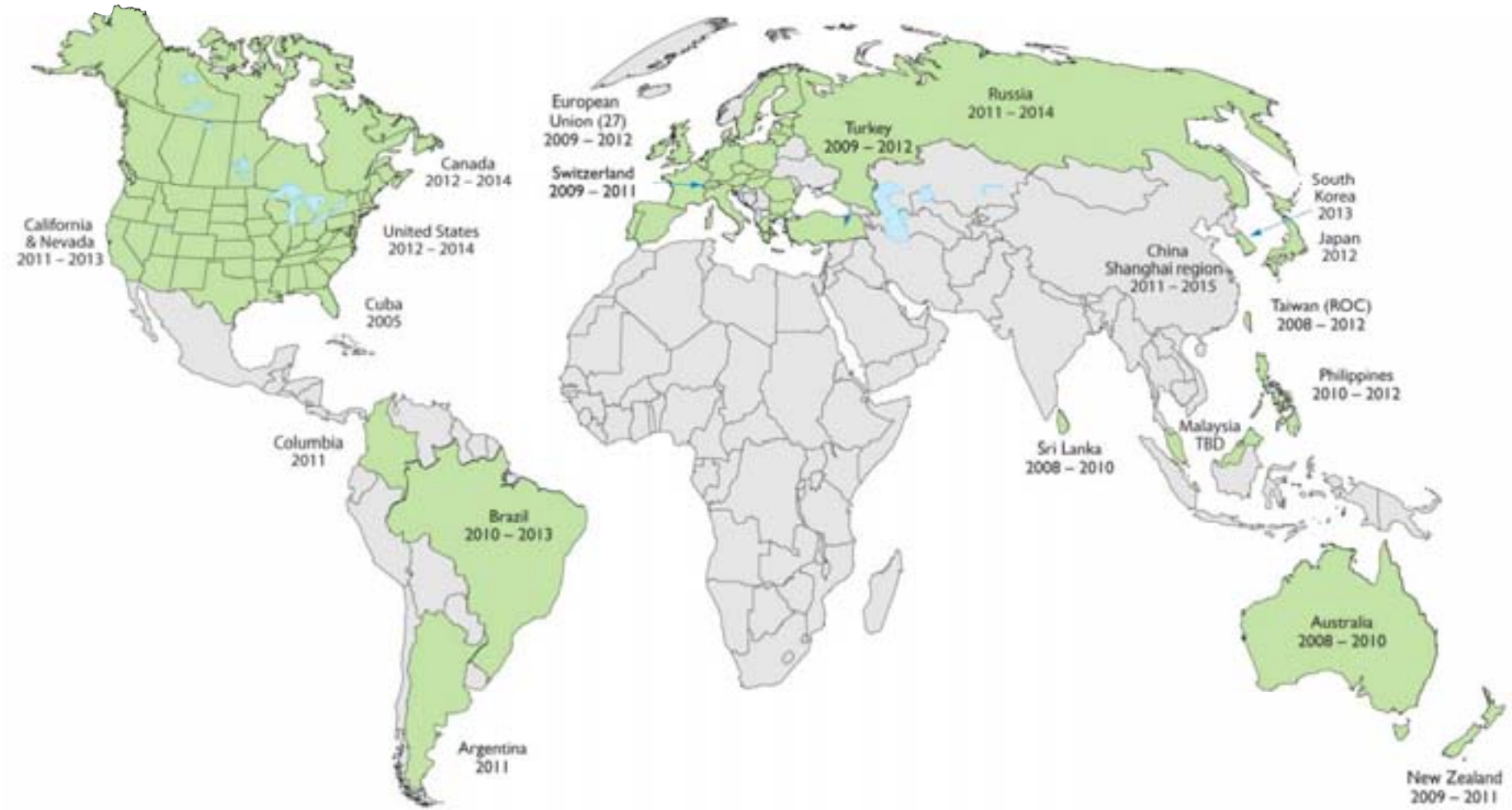
NSTAR Exelon

ENERGY STAR

U.S. DEPARTMENT OF ENERGY

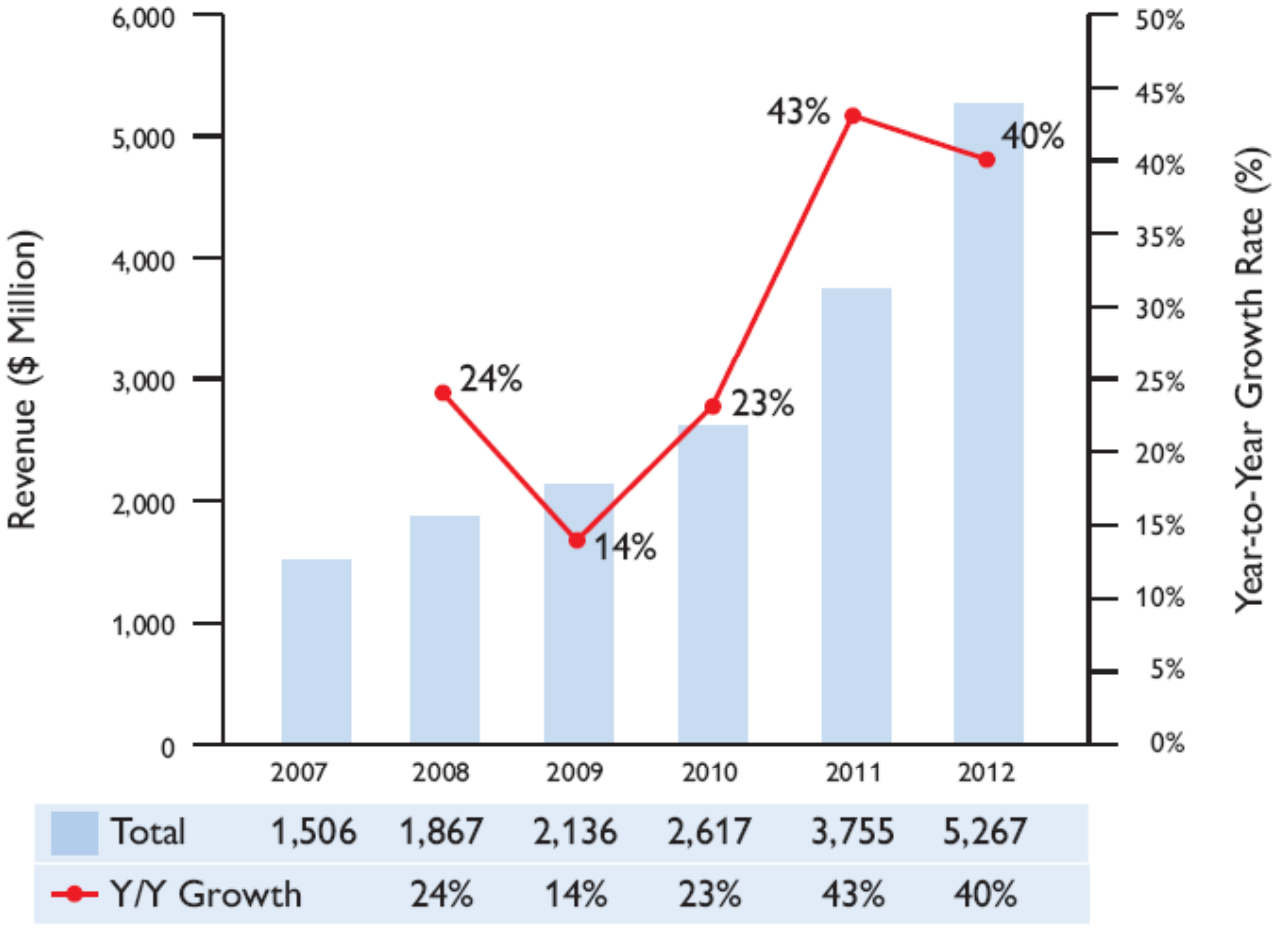
Global Incandescent Lamp Phase-Out

Plus United States T-12 fluorescent Phase-Out 2012



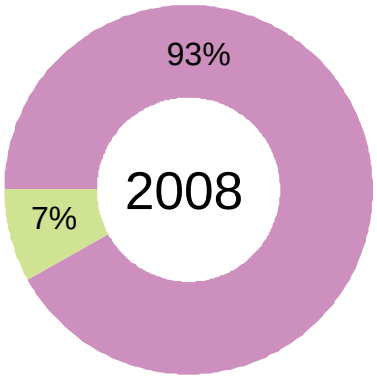
Global LED Lighting Fixture Market Size

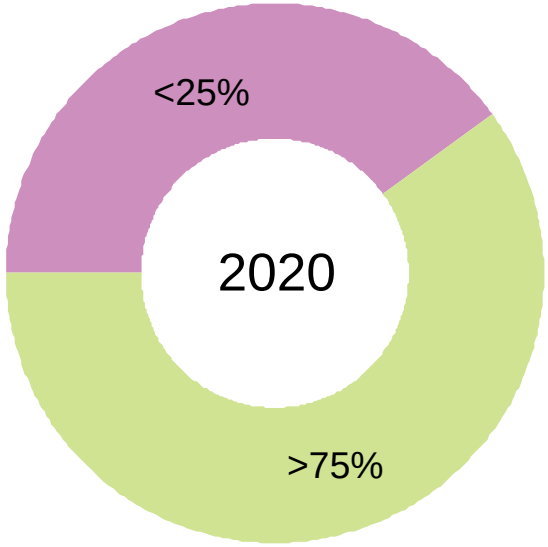
In 2009, the total global market for LED lighting was about $2.1 billion, 43% of which was in North America alone. This market is expected to double to $5.3 billion by 2012.



The Digital Revolution

*LED lighting is transforming the entire landscape**





Traditional lighting

LED lighting

*Market estimate based on internal Philips study

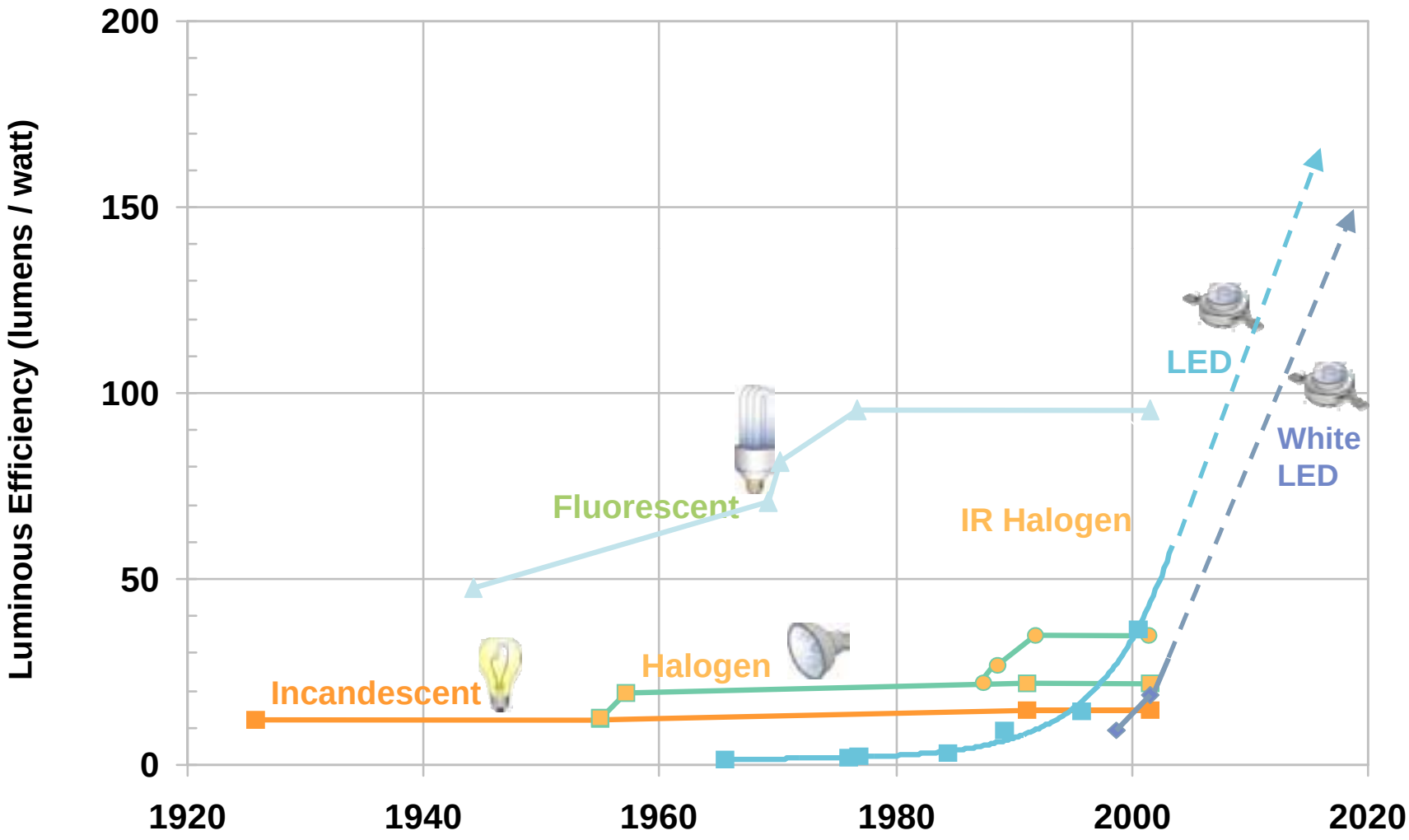


Demand for Energy Increasing

Environmental Benefits of LEDs vs Traditional Light Sources

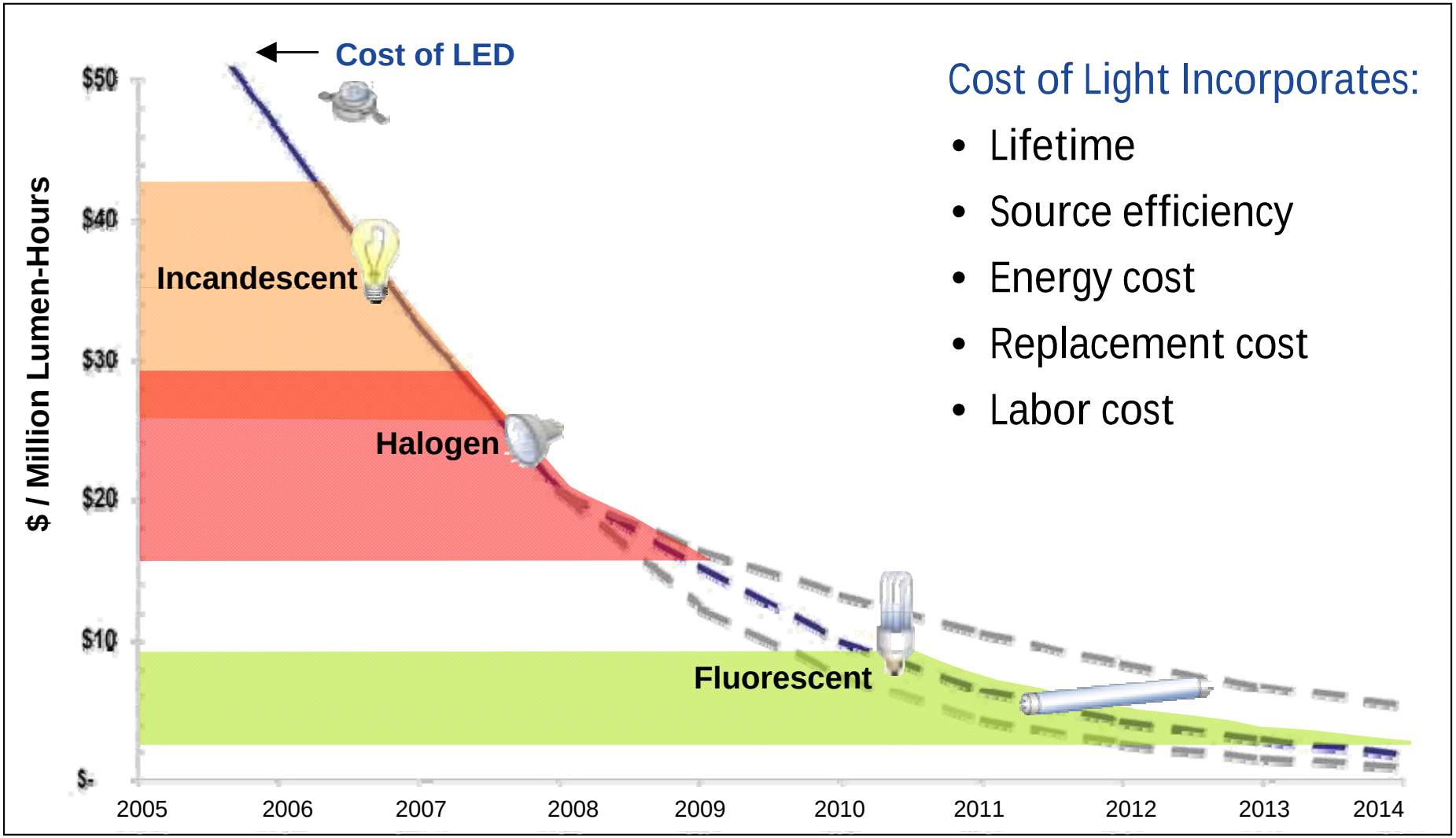


LED Source Efficacy



Source: Lumileds; Projections are Color Kinetics estimates

The Cost of Light



Cost of Light Incorporates:

- Lifetime
- Source efficiency
- Energy cost
- Replacement cost
- Labor cost

Demand for Energy Increasing

LEDs Offer Real Life Solutions



Before = Metal Halide
- 10,000 Hour Lamp Life
- 4000K
- 175 Watt
- 5 Minute Warm Up Time



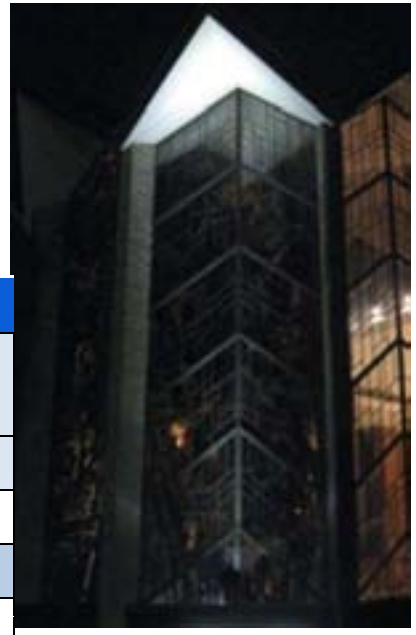
After = eW Blast LED
- 70,000 Hour Lamp Life
- 4000K
- 50 Watt
- Instant On (no warm up)
- Mounted to existing junction box



LED floodlight providing a high-intensity white light. Rated for outdoor use, it is ideal for applications as diverse as highlighting architectural features, general site illumination, and lighting signage and retail spaces.

- Beam Angles = 21° and 10°
- Power Input = 100 to 240 VAC
- Power Consumption = 50 Watts
- Lifetime = 70,000 hours L70 @ 25° C
- Color Temperature = 2800K & 4000K
- Operating Temp = -4° – 122° F

LED Flood Light vs Metal Halide



Cost Comparison		
Installation	**eW Blast Powercore** 50 Watts	**Metal Halide** 175 Watts
Lumen Output	2,390	10,000
Number of fixtures	1	1
Fixture Cost (MSRP)	$499	$284
Number of Lamps	0	1
Lamp Cost (MSRP)	$0	$40
Installation ($47 / hr)[4]	$16	$16
TOTAL INSTALLATION COST	**$515**	**$300**
Maintenance		
Relamps per 70,000 hours	0	7
Lamp Replacement Cost	$0	$40
Lamp Replacement Labor Cost	$0	$12
TOTAL MAINTENANCE COST	**$0**	**$362**
Power (Based on $0.11 per KWH)		
Power Consumption (Watts)	50	175
TOTAL POWER COST of 70,000 hours	**$385**	**$1,348**
TOTAL COST OF OWNERSHIP	**$900**	**$2,010**
Average Annual Cost 6 hrs per day over 31 years	**$28**	**$63**



50 W LED



175 W MH

LED System Cost Savings

LED Lighting Systems pay for themselves, resulting in significant long-term cost savings.

- The Cost of Light is not simply the up-front cost
- Industry Cost of Light criteria

- Energy costs
- Power consumption
- Labor costs

- Lamp costs
- Lifetime
- Light output





LED System Benefits



Conventional Lighting Sources

- Incandescent



- Halogen



- Fluorescent



- Gas-discharge (example: neon)



SSL Source

Light Emitting Diodes (LEDs)

Benefits of SSL

- Ultra long source life (25-90K hrs)
- Highly efficient, 70+ lumens/watt
- Low power consumption
- Low maintenance
- No moving parts
- No UV emissions
- No radiated heat (IR) from light
- Digitally controllable
- Unaffected by cold temperatures
- Unaffected by high vibration
- Fast response

A Brief LED History

- 1962 First visible LED (Holonyak@GE)
  - 0.001 lumens
- 1960's Red LEDs (HP and Monsanto)
  - 0.01 lumens
- 1970's–1980's Green LEDs, Watches, Calculators
  - 0.1 lumens
- 1990's Blue LEDs (Nakamura@Nichia)
  - 1 lumen
- 2000+
  - 10-100 lumens
- 2005
  - 1000 lumens (multichip packages)
- 2010
  - 11,392 lumens (Outdoor Architectural Flood Light)







Emerging Applications in LED General Illumination

- Indoor Lighting
  - Display Case
  - Cove
  - Downlights
  - Accent
  - Task
- Outdoor Lighting
  - Street / Parking Lot
  - Bollards
  - Parking Garage
  - Flood
- Lamp Replacements
  - A Lamps, PARs, MR16s…











LEDs 101

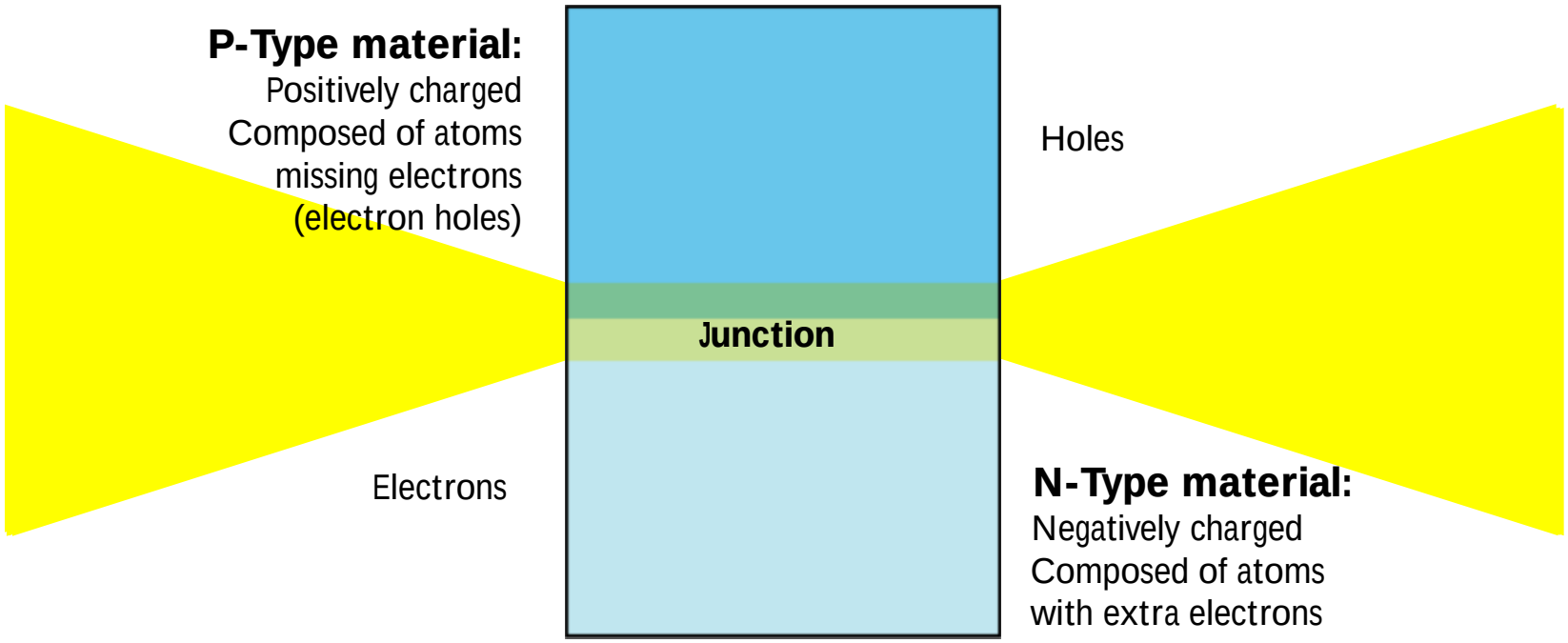
01 Introduction

02 LED Component Basics

03 LED Lighting Application Examples

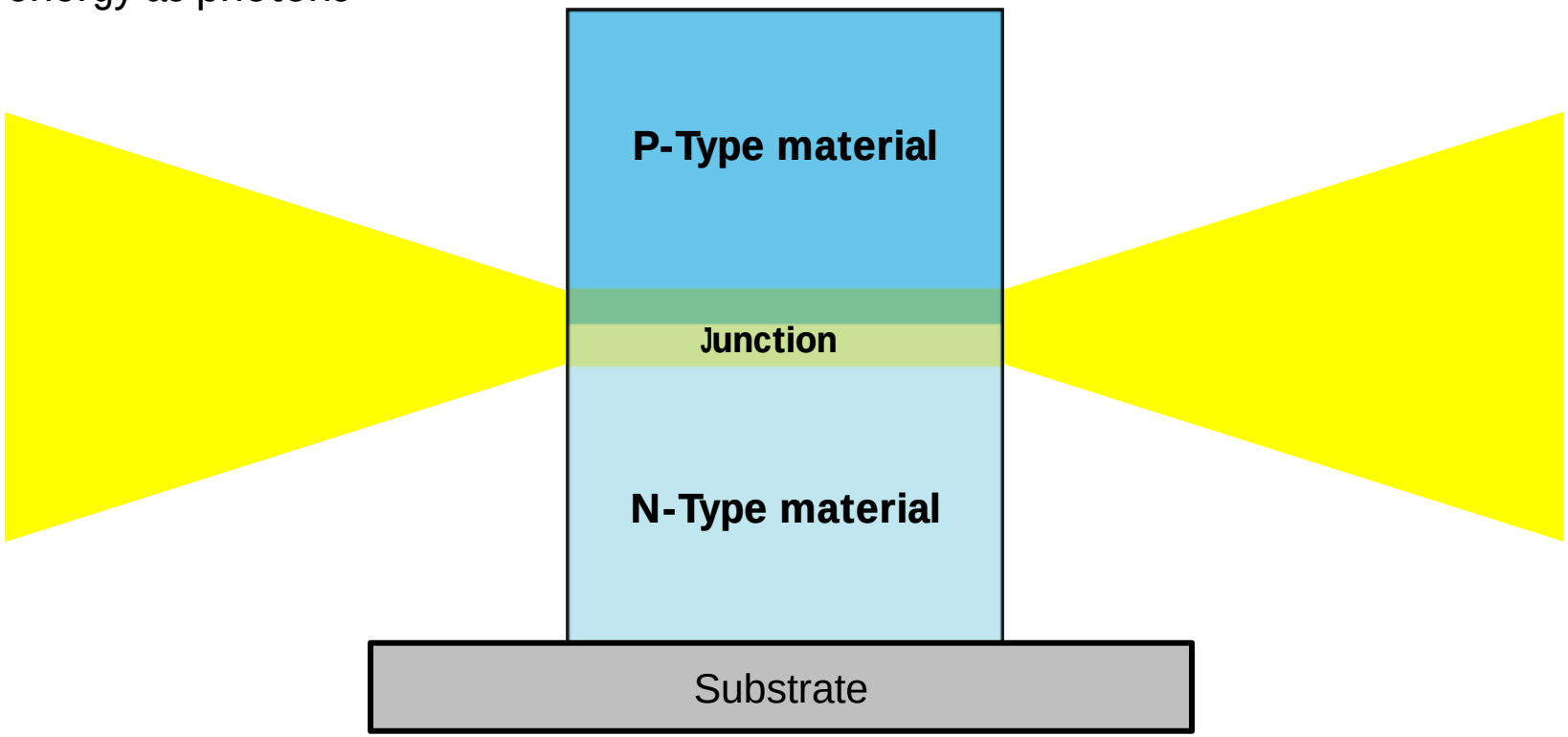
How LEDs Work

Like all diodes, LEDs consist of a single p-n junction



How LEDs Work continued...

- Forward bias: A negative charge is applied to the n-type side, causing current to flow toward p-type side
- Extra electrons in the n-type material fall into holes in the p-type material, releasing energy as photons



Types of LED Sources

5mm LED vs High Power LED

HB LED PRODUCT SEGMENTATION

Product Segment	Input Current (mA)	Input Power (W)	Luminous Flux (lm)	Luminous Efficacy (lm/W)
Standard Lamp Packages (3-mm, 5-mm, SMD)	5–20	0.04–0.08	0.1–6	2–90
High-Current Packages (e.g., Lumileds SuperFlux, SnapLED; OSRAM Power TOPLED, Nichia Raiden)	30–150	0.08–0.36	0.2–20	2–38
High-Power Packages (e.g., Lumileds Luxeon and K2, Nichia Rigel and NS6, OSRAM Golden DRAGON, Cree XLamp, Seoul Semiconductor Z-Power)	150–1,400	0.5–4.8	4–190	8–90
RGB Multichip Packages (typically one red, one green, and one blue chip)	Variable	Variable	Variable	Variable

Flux ↑



High power/brightness LEDs
Power: 1-5 W
Flux: >80 lm



Medium power LEDs
(Surface mounted device)
Power: 0.5W
Flux: 0.1-12 lm

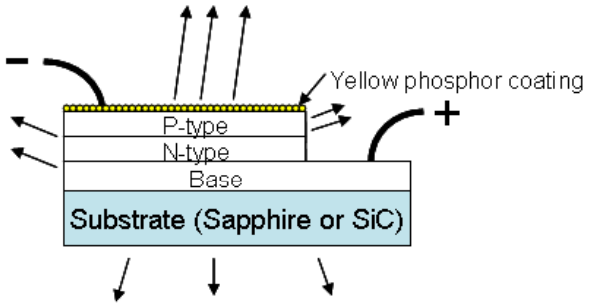


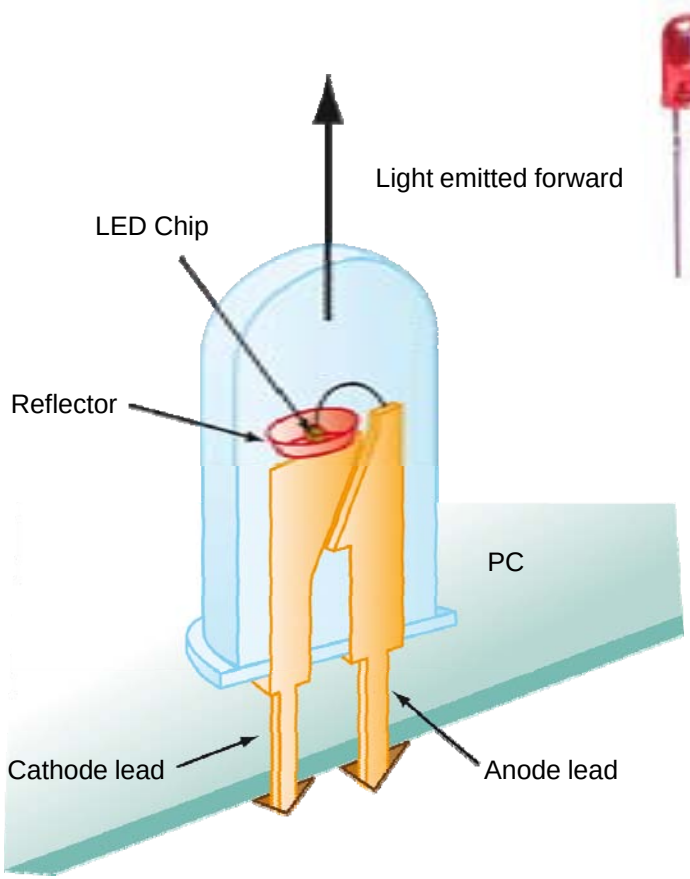
Low power LEDs (5mm)
Power: 0.3W
Flux: 1-3 lm

Power →

Types of LED Sources

5mm LED vs High Power LED

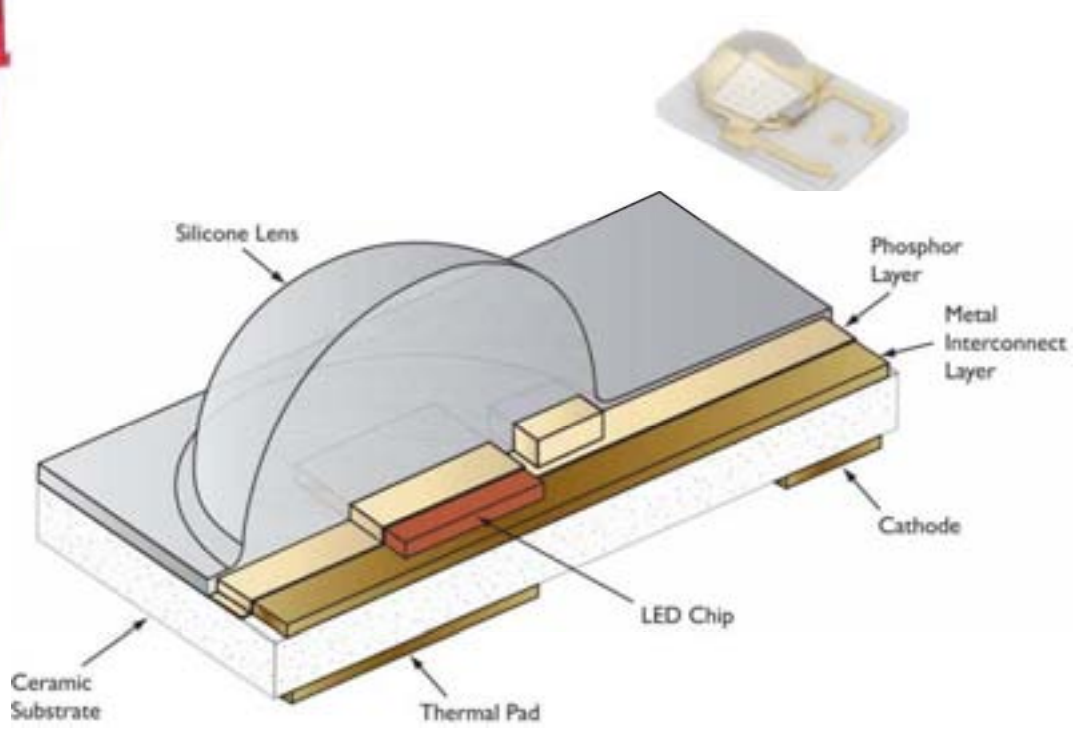




Inexpensive

Low-power

Commonly used in electronic displays or instrument illumination

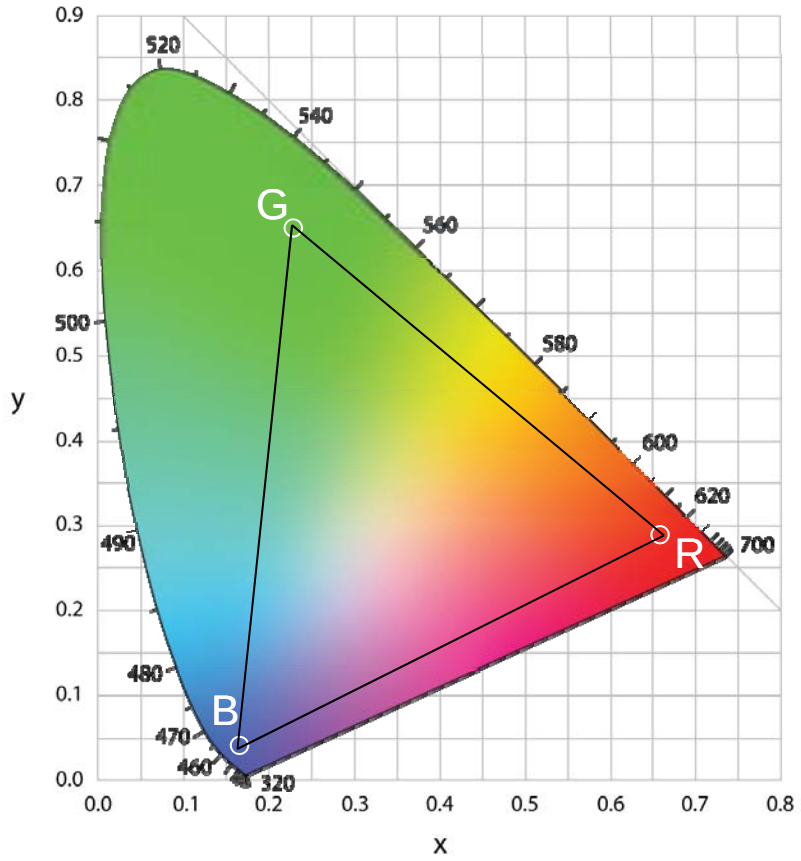


Durable, high-power devices that provide functional illumination

How LEDs Produce Millions of Colors

Tri-color (RGB) LED fixtures combines red, blue, and green in varying intensities to generate millions of colors

Color range (gamut) determined by the colors of the individual LEDs

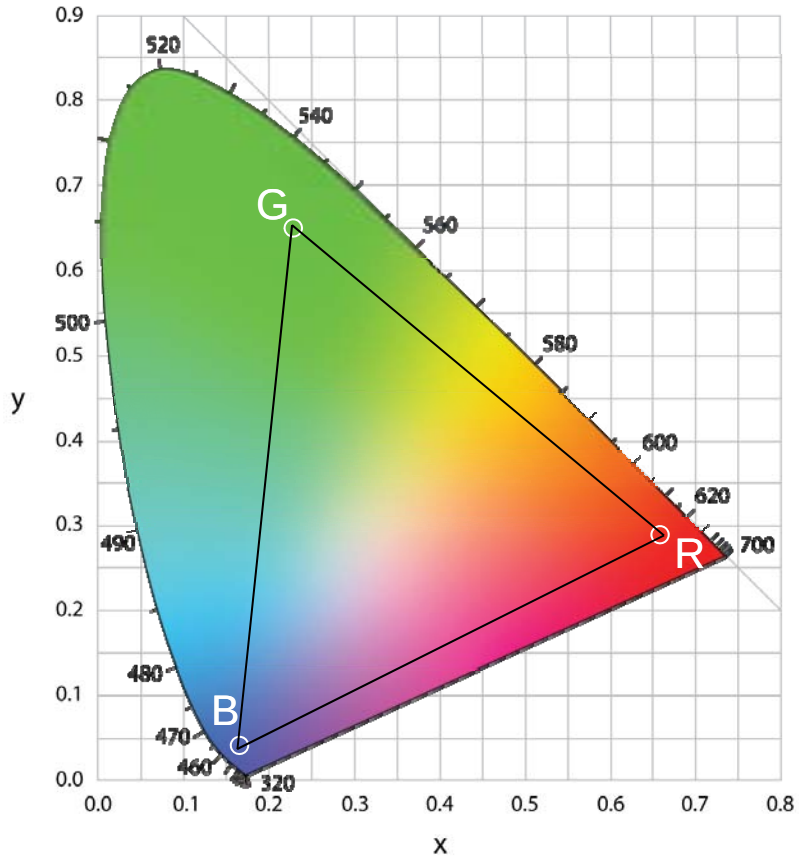


CIE 1931 Color Space

More Colors than the Eye Can See

Three-channel, 8-bit fixtures produce 16.7 million colors — more colors than the human eye can detect

Colors outside the range are detectable but cannot be produced



CIE 1931 Color Space

How LEDs Produce White Light: RGB White

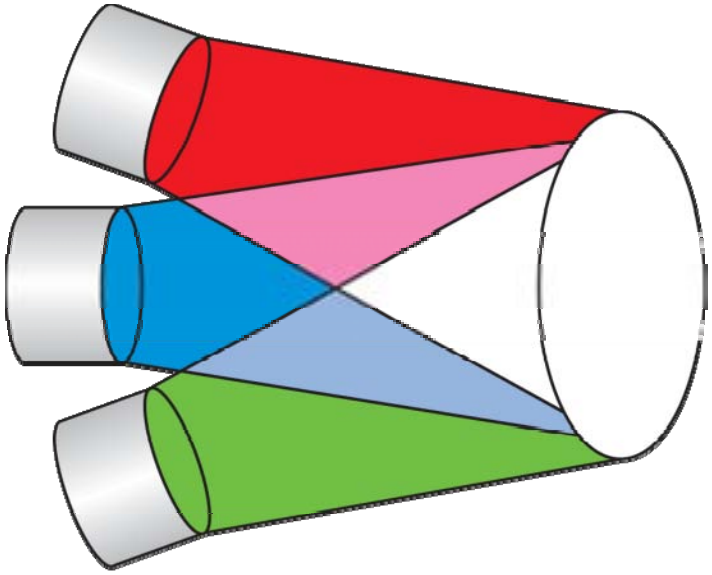
Produces white light by combining red, green, and blue LEDs

Makes colors “pop”

Provides control over exact color of light

Hardware intensive: requires three LEDs

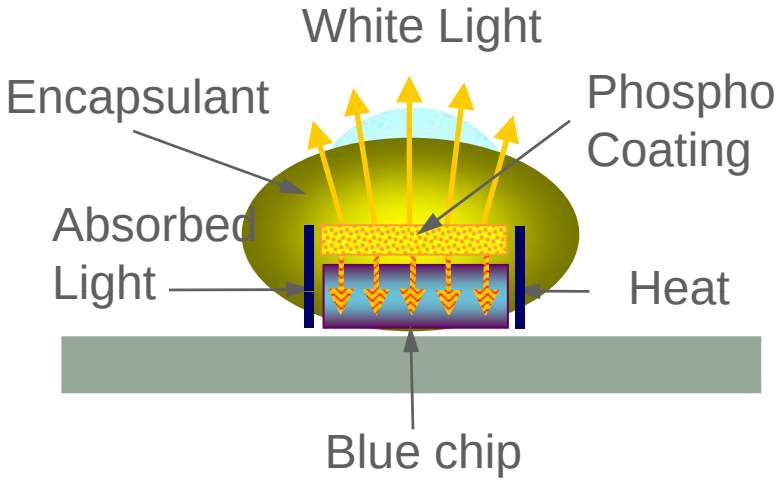
Renders pastel colors unnaturally



How LEDs Produce White Light:

Phosphor coating LED Source

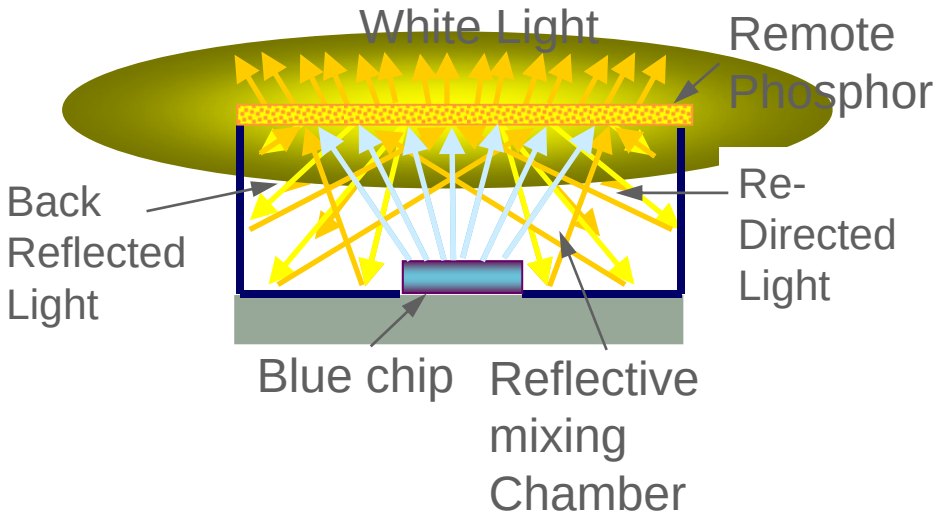




Remote Phosphor



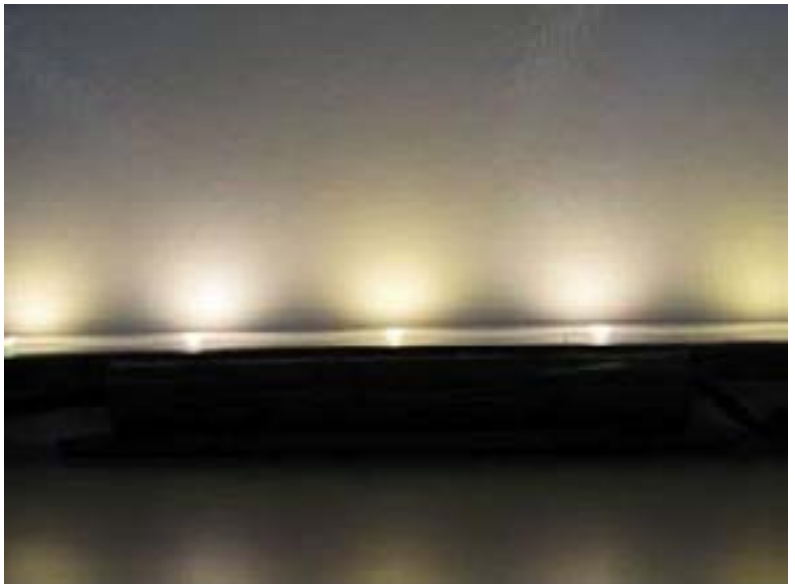




Color Quality / Consistency
LED To LED And Over Time

- In any array, you will inevitably have a mixture of LED sources with varying flux and color
- LED source binning and selection for fixture placement provide a solid foundation for success
- To achieve uniformity, you need to mix the light from the different LEDs together using a mixing chamber and/or optics
- LED sources can exhibit color shift over life which increases with higher junction temperatures
- Color shift is dependent on LED product quality and junction temp. Some poor quality LEDs still have color shift even with lower junction temps.





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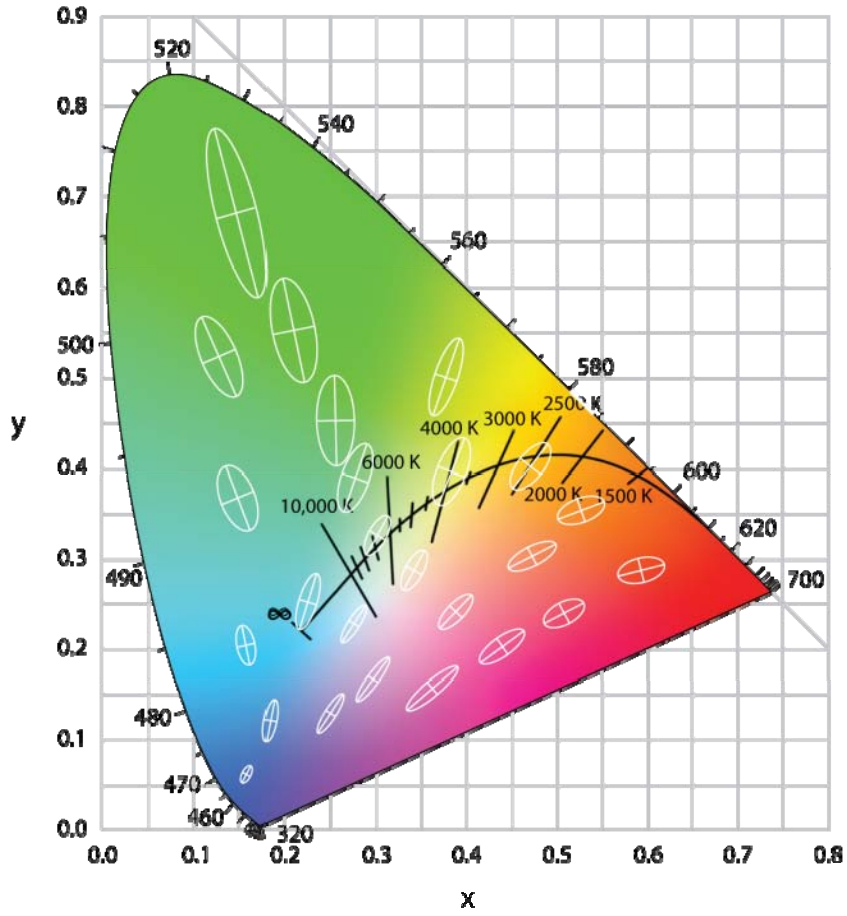
Measuring Color Variations

- The threshold at which color variations becomes perceptible is defined by a *MacAdam ellipse*
- Scale of a MacAdam ellipse is determined by *standard deviations of color matching* (SDCMs):
  - 1 SDCM step is not visible
  - 2 to 4 steps are barely visible
  - 5+ steps are readily visible



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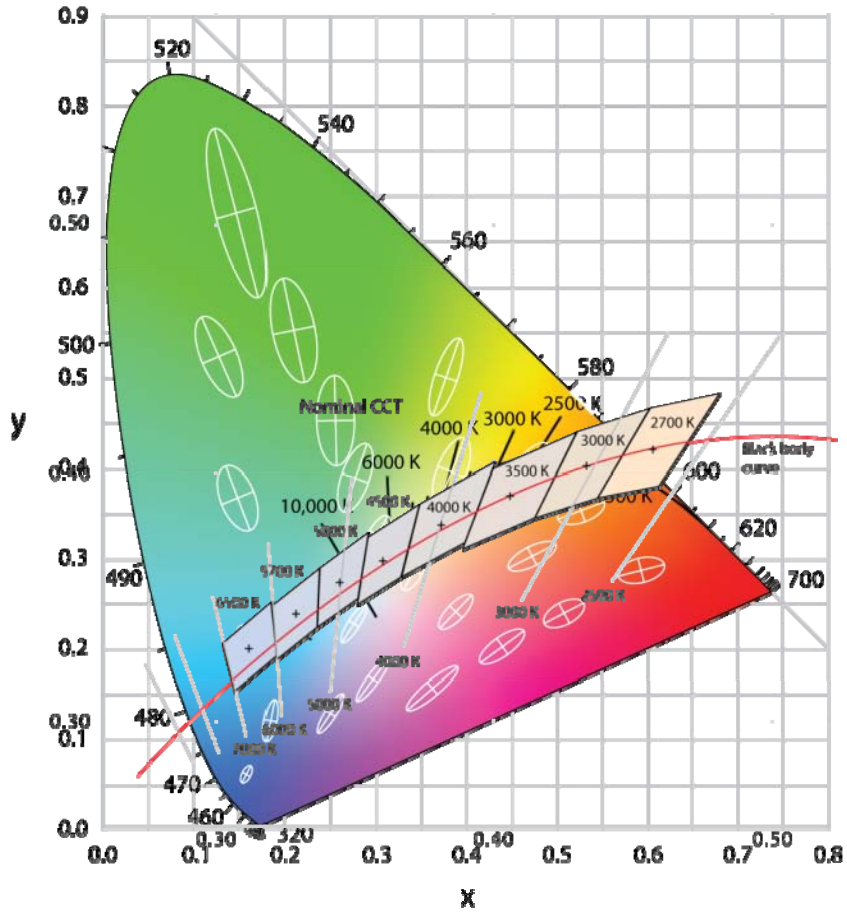
ANSI Chromaticity Standard

- ANSI Chromaticity Standard C78.377A defines 8 nominal CCTs
- Color ranges of CCTs are defined by boxes surrounding 7-step MacAdam ellipses
- LED sources that fall within the defined boxes conform to the standard



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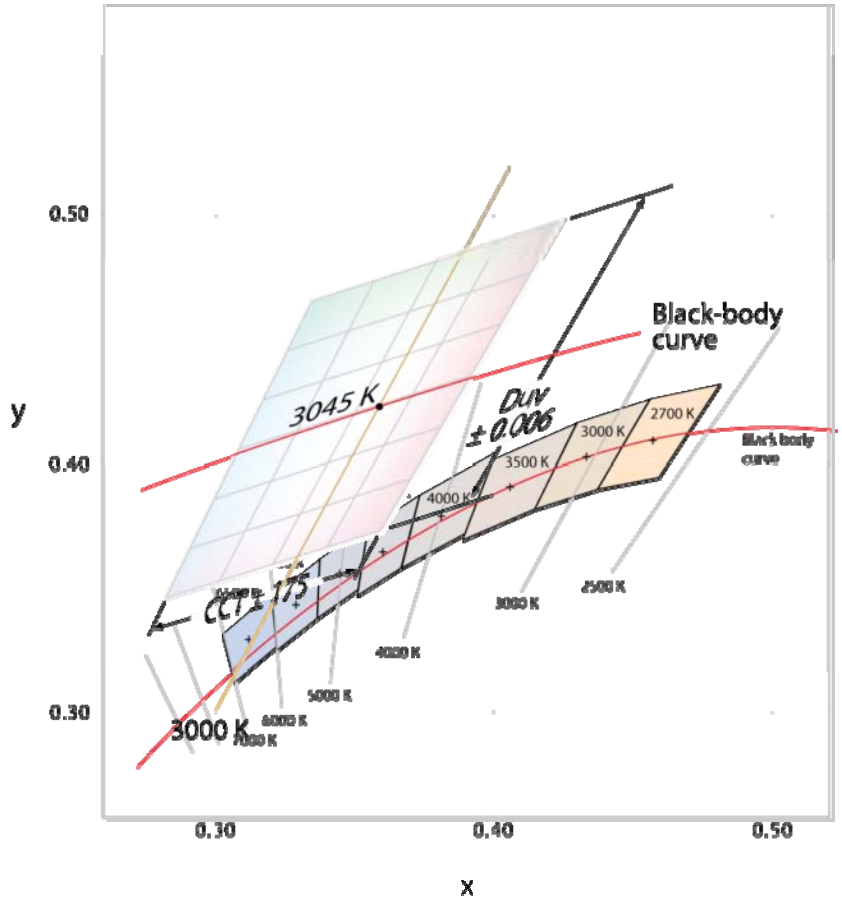
ANSI Chromaticity Standard continued…

- The size of each box is determined by the ANSI CCT and Duv ranges. Nominal CCT of 3000 K:
  - Centers on 3045 K, with a tolerance + / – 175 along the black body curve
  - Extends 0.006 Duv above and below the black-body curve
- In practice, measured CCT and Duv can vary considerably and still be 3000 K



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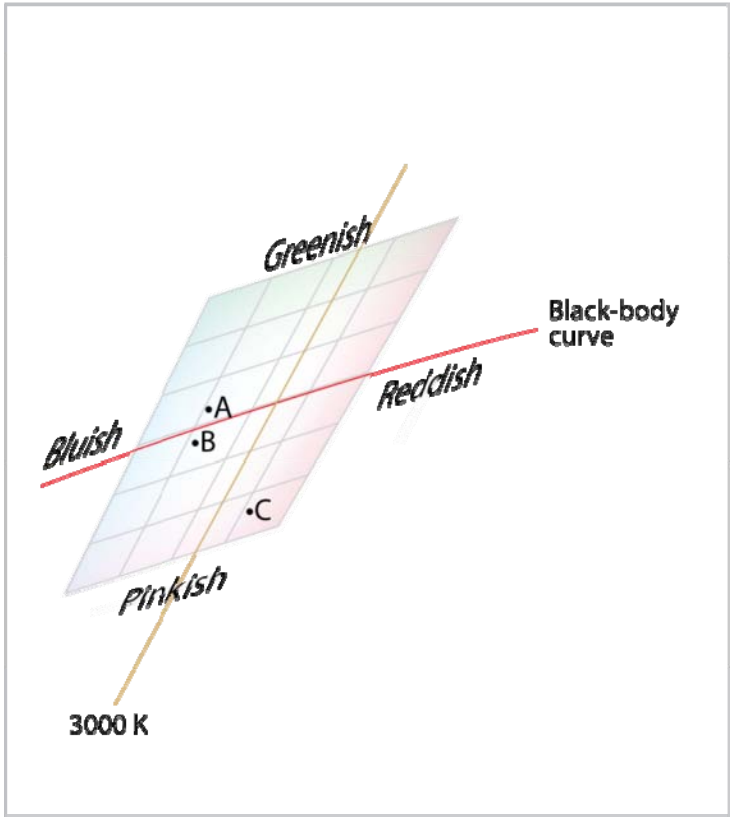
ANSI Chromaticity Standard continued…

- Bluish – reddish variations lie along the black-body curve
- Greenish – pinkish variations lie above and below the black-body curve
- Color differences between light sources A and B are negligible
- Color variations between A and C are about 4 times as great
- Yet all three light sources are nominally 3000 K



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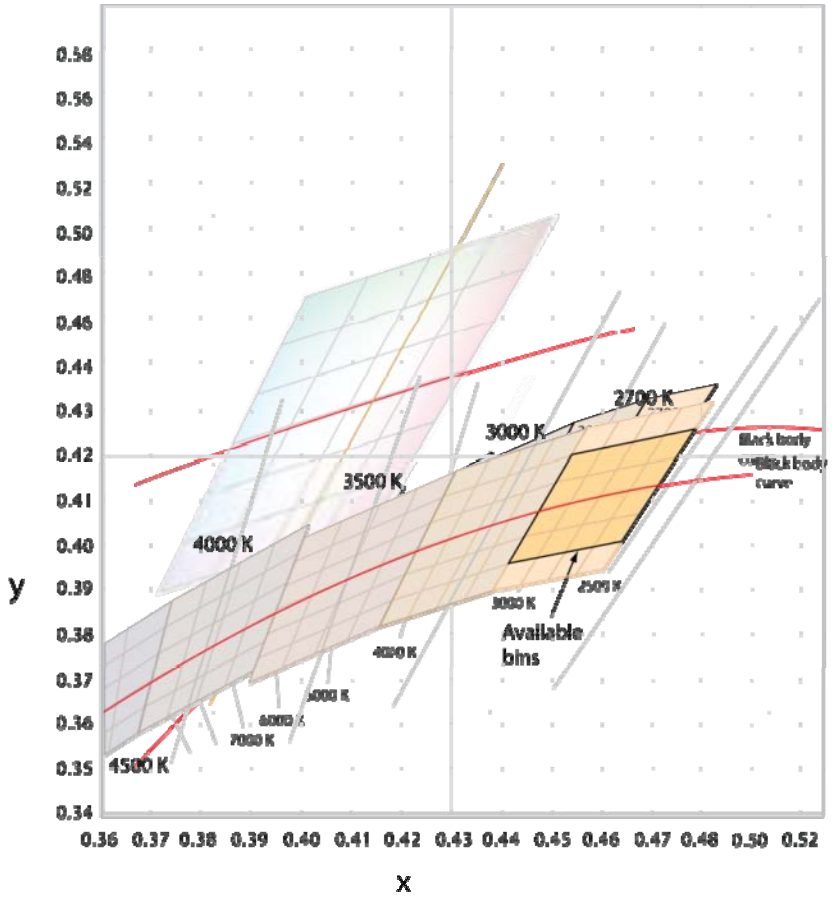
Ensuring Color Consistency with Binning

- In practice, LED makers manage variations by subdividing each CCT area into subclasses or *bins*
- Bins within each subdivided area conform to the ANSI CCT standard
- Color variations within individual bins are undetectable



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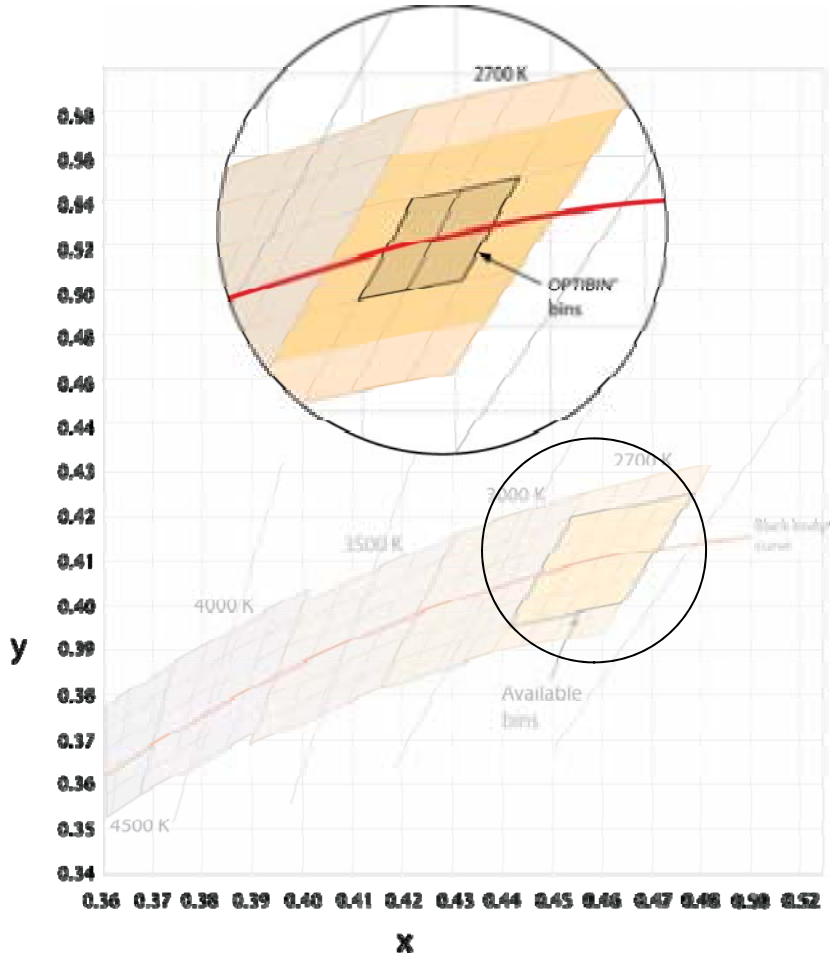
Ensuring Color Consistency with Binning continued...

- LED lighting fixture manufacturers select bins to minimize color differences between fixtures
- Binning schemes are mathematical models for selecting LED source bins
- Some binning schemes are stricter than the ANSI standard
- Selecting only bins within a 4-step MacAdam ellipse guarantees color uniformity



Tunable LED White-Light Fixtures







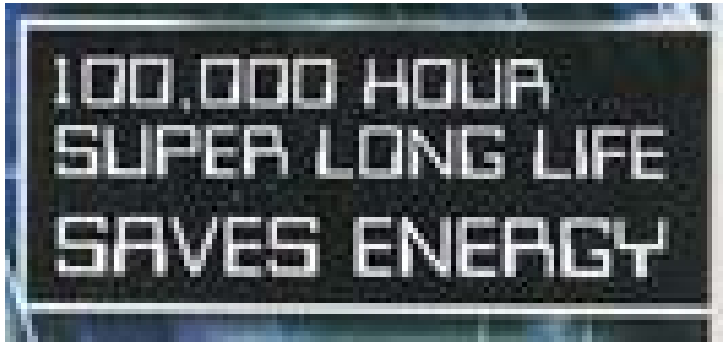


Use color-mixing principles of tri-color LED devices to produce a range of color temperatures
Combine channels of cool and warm white LEDs

Rustic Kitchen, Boston, Massachusetts
Photo: John Brandon Miller

LED System Lifetime
Importance of Thermal Management





Useful Life versus Rated Life

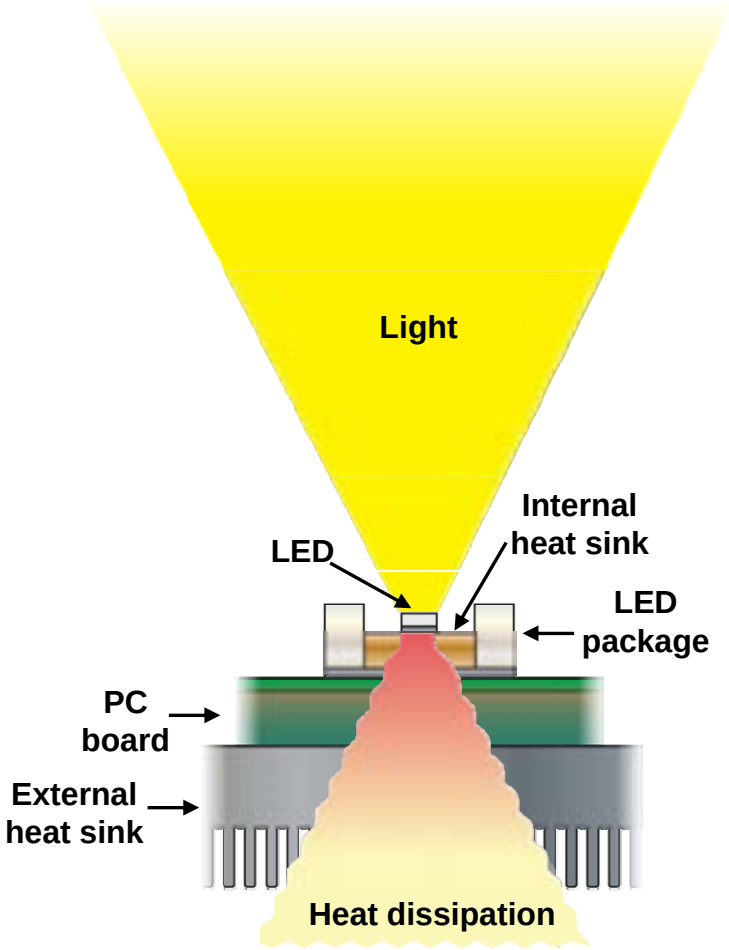
- Useful life = The number of hours an LED lighting fixture will deliver a sufficient amount of light in a given application
- Conventional light sources stop delivering sufficient light when they fail
- Accurate comparison: rated life of conventional light sources vs. useful life of LED lighting fixtures

Useful Life versus Fixture Lifetime

- Useful life is not *fixture lifetime*
- Fixture lifetime = the reliability of every component within an LED lighting fixture — electronics, housing, wiring, etc.
- Fixture fails when the component with the shortest lifetime fails (rarely the LEDs)

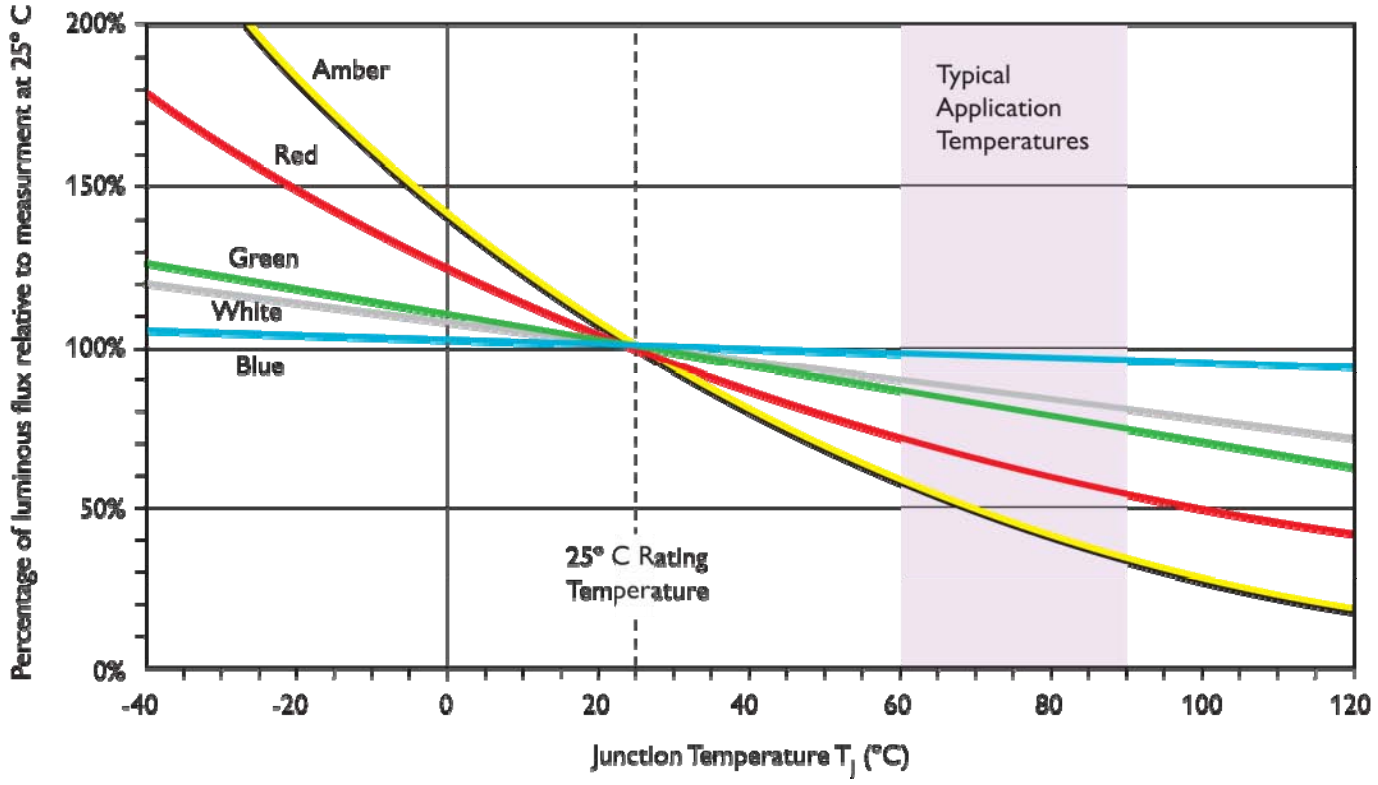
LED System Lifetime
Importance of Thermal Management

- LEDs produce a fair amount of waste heat
- Excess heat reduces light output and shortens useful life
- Therefore, LED fixture design must effectively channel heat away from LED sources
- Thermal management features typically include an effective thermal path and heat sink



Junction Temperature Affects Light Output

High junction temperatures can cause amber and some red LED sources to color shift



LED Sources Have a Long Useful Life

Time to % lumen maintenance

- Conventional Sources
  - Time to lumen depreciation targets exceed time to failure
  - Conventional fixture reliability is dependent on the lamp (rated life) and the ballast (one yr warranty is typical)
  - Useful Life = typically stated as rated life, time to failure, of the lamp

Life Projections for LEDs and Traditional Light Sources	
Light Source	**Typical Lifetime Range (Hours)**
Incandescent	750 – 2,000 / rated life
Halogen Incandescent	2,000 – 4,000 / rated life
CFL	8,000 – 10,000 / rated life
Metal halide	7,500 – 20,000 / rated life
Linear Fluorescent	20,000 – 30,000 / rated life
White-light LED	35,000 – 50,000 / useful life (L70)

- LED sources
  - LED source itself is extremely robust
  - LED lighting fixture reliability is highly dependent on quality of design, test, manufacture and supply
  - Useful Life = time to lumen depreciation target for LED source (common view)
    - *BUT* other component failures are leading cause of LED fixture failures

Getting Dependable, Accurate Information

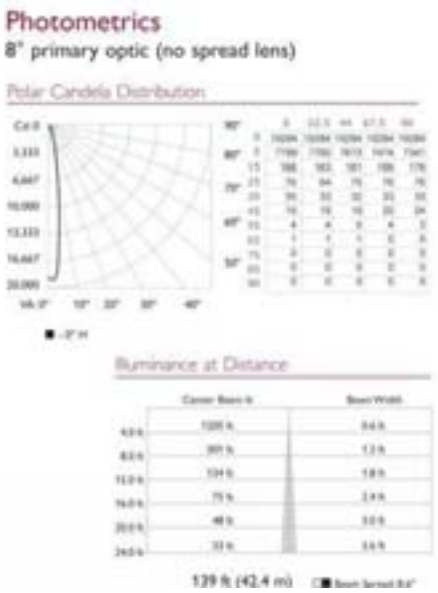
- Reputable LED fixture manufacturers ensure that drive currents and operating temperatures fall within ranges specified by LED source manufacturers
- But without standard extrapolation method, there is no guarantee that all companies conform to this practice
- Look for comprehensive specifications and photometric data for LED fixtures



Specifications

Due to continuous improvements and innovations, specifications may change without notice.

Item	Specification	Details
Output	Beam Angle	8° primary optic
	Lumens†	647
	Color Range	16.7 million additive RGB colors; continuously variable intensity
	Lumen Maintenance‡	120,000 hours L50 @ 25° C 70,000 hours L50 @ 50° C
Electrical	Input Voltage	100 – 240 VAC, auto-switching, 50 / 60 Hz via Data Enabler Pro
	Power Consumption	30 W maximum at full output, steady state
Control	Interface	Data Enabler Pro (DMX or Ethernet)
	Control System	Philips full range of controllers, including Light System Manager and iPlayer 3, or third-party DMX controllers
	Dimensions (Height x Width x Depth)	10.8 x 8.0 x 6.8 in (274 x 204 x 175 mm) Architectural 10.7 x 6.4 x 6.8 in (271 x 163 x 175 mm) Landscape
	Weight	11 lb (5 kg) Architectural 7.4 lb (3.4 kg) Landscape
	Housing	Die-cast aluminium, gray powder-coated finish
	Lens	Tempered glass



Photometrics

8° primary optic (no spread lens)

Polar Candela Distribution

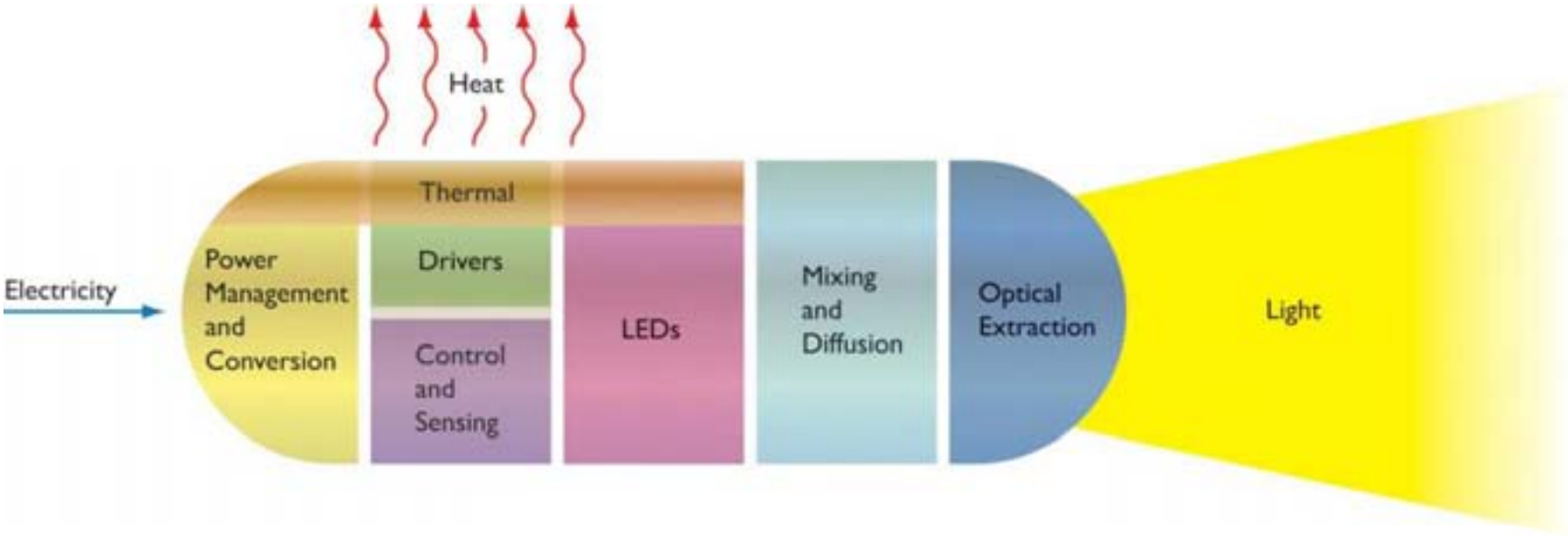
Luminance at Distance

139 ft (42.4 m)

Getting Dependable, Accurate Information continued...

- Verify that:
  - LED sources in the fixture were LM-80 tested
  - LED source manufacturer uses a valid method of projecting LM-80 test results to L_{70} or L_{50}
  - LED lighting fixture manufacturer performs its own measurements of junction temperature, drive current, and other factors
  - Fixture manufacturer bases its L_{70} or L_{50} figures on LM-80 extrapolations provided by the source manufacturer
  - Fixture manufacturer bases its photometric data on LM-79 test results from an independent NIST-traceable lab

LED Fixture Anatomy



LED Fixture Anatomy

Power Supply and Driver

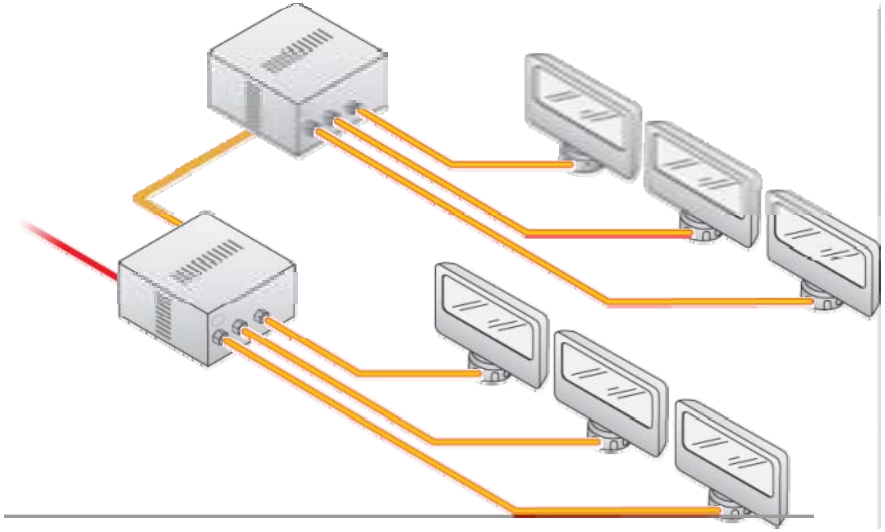
- LEDs are always driven by a constant-current DC power source
- High brightness or power LED generally refers to an emitter package of roughly 1W at a drive current of 350 mA
- The light output of an LED is proportional to the current applied, most high brightness LED sources will operate across a range of current
- Drivers also contain temperature sensitive electronic components
- There is energy lost in the power conversion, power supply efficiencies can vary from 90% all the way down to 50% or lower





Low Voltage Power Distribution

- Low-voltage LED fixtures use low-voltage power supplies or transformers
- Low-voltage systems are relatively inefficient: Conversion stages cause power loss
- A typical low-voltage configuration consists of a “star” configuration in which each fixture connects directly to the power supply





Inboard Power Integration



- Like low-power systems, but integrates standard switching power supplies into the fixture
- Simplifies setup and installation, but can increase fixture size and thermal load

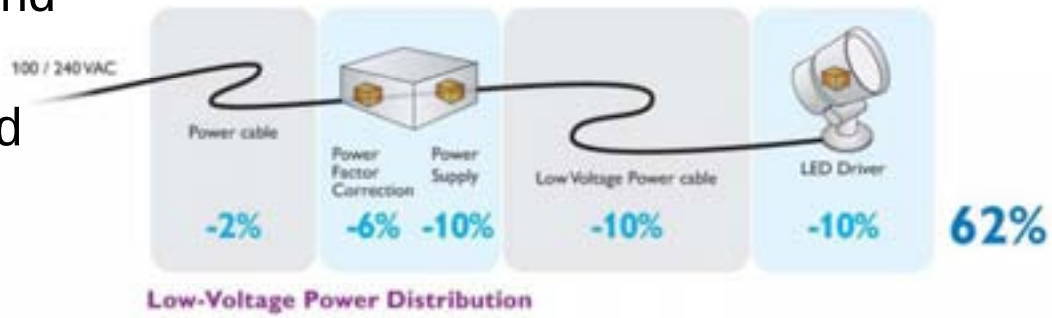
Onboard Power Integration



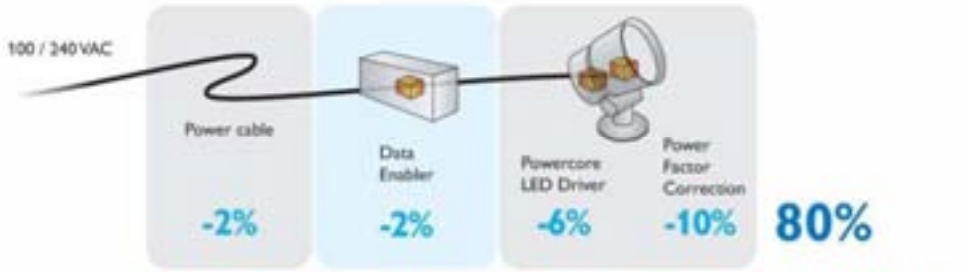
- Incorporates a power supply directly into the fixture’s circuitry
- Consolidates line voltage conversion and LED current regulation
- Increases system efficiency
- Lowers costs
- Simplifies installation, operation, and maintenance

Inboard Power Integration continued...

- Streamlines multiple conversion and regulation stages into a single, flexible, microprocessor-controlled power stage
- Efficiently controls power to LED systems directly from line voltage
  - Increases efficiency
  - Lowers the total cost
  - Reduces size
  - Simplifies Installation
  - Enables dimming with ELV-type dimmer, depending on the power supply type
  - Operates with energy saving detection systems



Low-Voltage Power Distribution



Inboard Power Integration for Color-Changing Fixture (Powercore)



Inboard Power Integration for White-Light Fixture (Powercore)

How Is The LED System Efficacy Determined

Lm/W relation from LED component to luminaire system





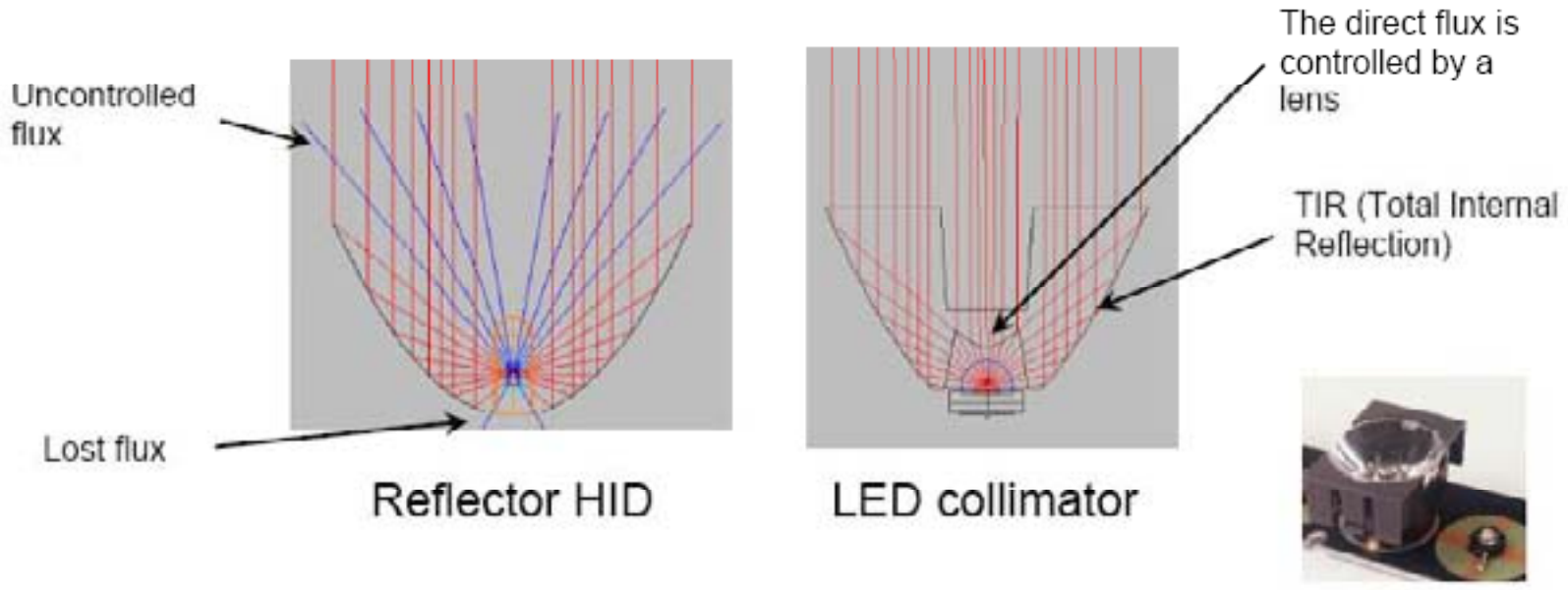


LED	LED array	Optics	Driver	Luminaire
• Color temperature • Temperature (Tj) • Drive current	• Thermal losses (higher Tj) *-10-15%*	• Optical losses *-10-30%*	• Driver losses *-10%-50%*	
100 lm/W →	85 lm/W →	70 lm/W →	50lm/W →	= system efficiency

Evaluating Light Output

It's not the lumens…

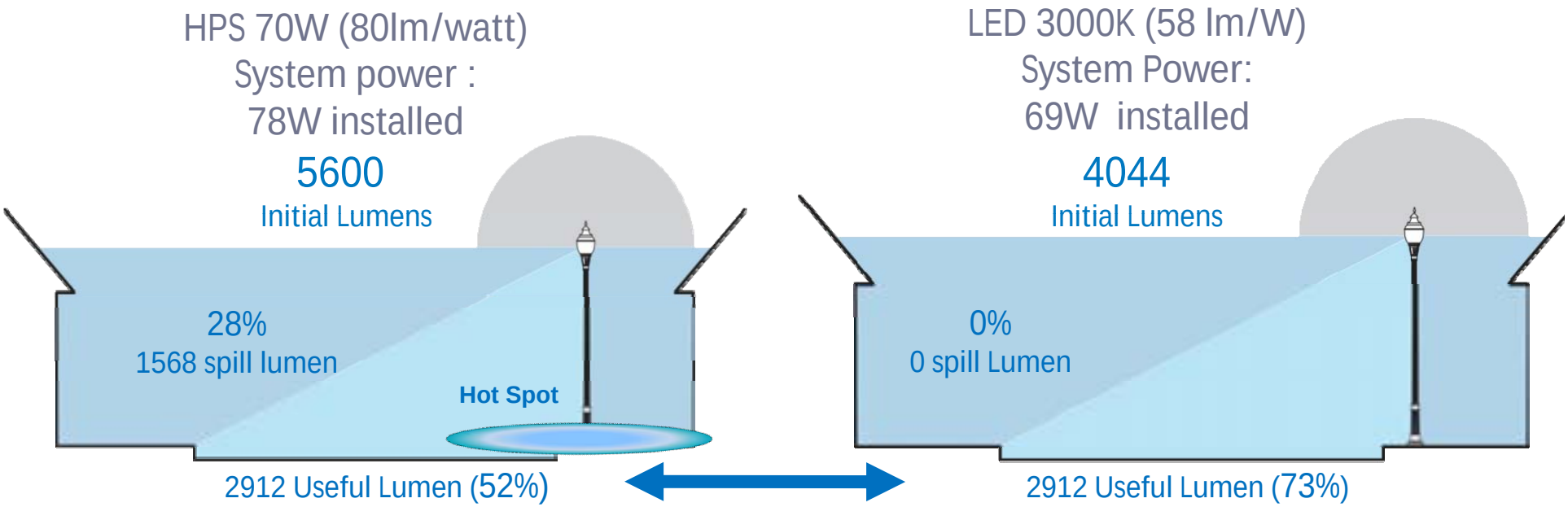
Total flux control :



The light output of an LED can be better controlled since an LED source is a small, directional light source

Evaluating Light Output

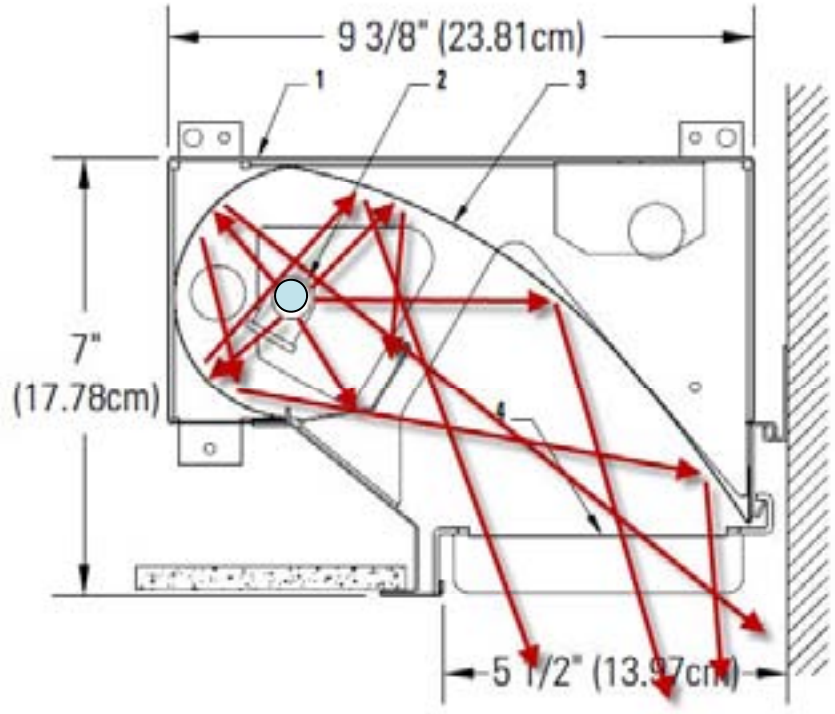
...but delivering the lumens where it's needed



- The entire system efficiency is key, don't be fooled by initial lm or lm/W
- Always check the useful lumen, illuminance (lux or foot candles on the surface to be illuminated), and/or the effect
- Software modeling is important
- Having samples and doing mock-ups are critical to success

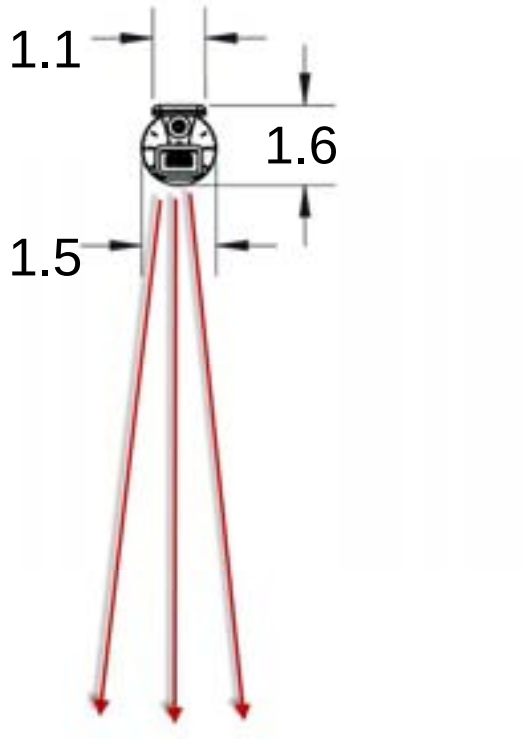
Remember – It's not about lamp lumens!

Perimeter Trough Recessed PTS5-1, 1 Lt T5 Aluminum Reflector



Lamp: T5HO
Lumens: 5000

LED Wall Graze, 1FT, 10x60, 3000K

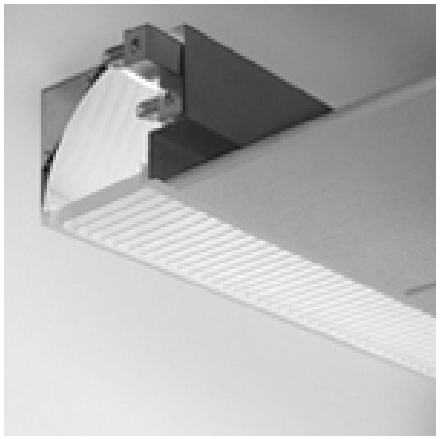


Lamp: LED Source
Lumens: 602

Comparison - Linear Fluorescent Grazing



Perimeter Trough Recessed PTS5-1, 1 Lt T5 Aluminum Reflector



4FT RECESSED PERIMETER FIXTURE MP-4ft.-1 T5-EBB



LED Wall Graze 1FT, 10x60

Characteristics

Lumens Per Lamp	5800 (1 lamp)
Total Lumens	5800
Luminaire Lumens	1064
Total Luminaire Efficiency	37 %
Luminaire Efficacy Rating (LER)	32
Total Luminaire Watts	58
Ballast Factor	1.00
CIF Type	Direct
Spacing Criteria (0-180)	0.68
Spacing Criteria (90-270)	0.90
Spacing Criteria (Diagonal)	0.60
Basic Luminous Shape	Rectangular w/Sides
Luminous Length (0-180)	0.42 ft
Luminous Width (90-270)	1.00 ft
Luminous Height	0.02 ft

465 lm/ft

35 fc @ 8 ft.

Characteristics

Lumens Per Lamp	2700 (1 lamp)
Total Lumens	2700
Luminaire Lumens	1116
Total Luminaire Efficiency	42 %
Luminaire Efficacy Rating (LER)	35
Total Luminaire Watts	31
Ballast Factor	1.00
CIF Type	Direct
Spacing Criteria (0-180)	0.86
Spacing Criteria (90-270)	1.12
Spacing Criteria (Diagonal)	0.94
Basic Luminous Shape	Rectangular
Luminous Length (0-180)	0.30 ft
Luminous Width (90-270)	0.67 ft
Luminous Height	0.00 ft

287 lm/ft

12 fc @ 8 ft.

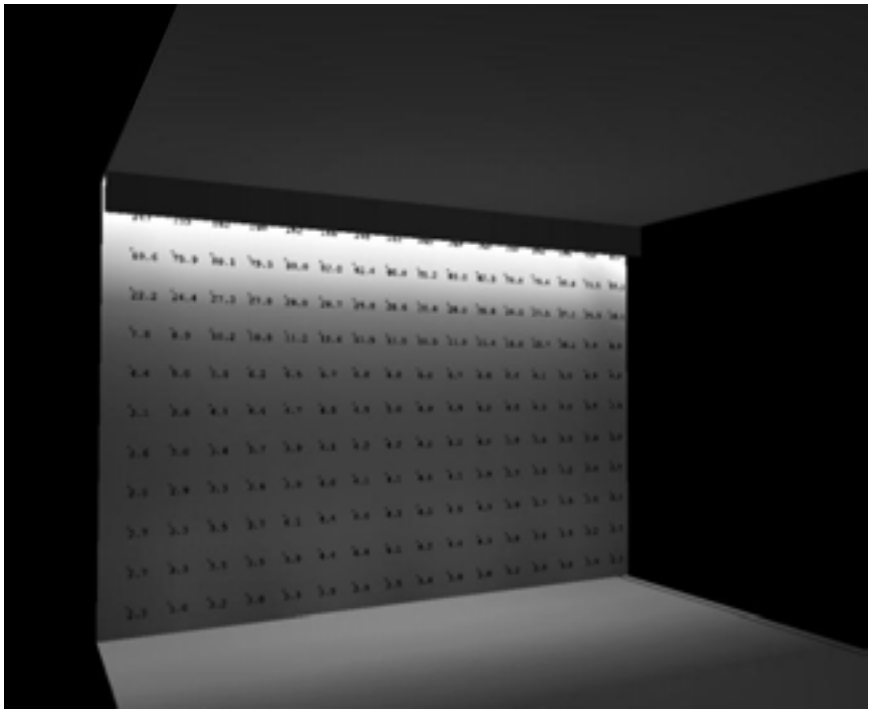
Characteristics

Lumens Per Lamp	N.A. (obsolete)
Total Lumens	N.A. (obsolete)
Luminaire Lumens	602
Total Luminaire Efficiency	N.A.
Luminaire Efficacy Rating (LER)	57
Total Luminaire Watts	10.6
Ballast Factor	1.00
CIF Type	Direct
Spacing Criteria (0-180)	0.22
Spacing Criteria (90-270)	0.98
Spacing Criteria (Diagonal)	0.44
Basic Luminous Shape	Rectangular w/Sides
Luminous Length (0-180)	0.10 ft
Luminous Width (90-270)	1.00 ft
Luminous Height	0.06 ft

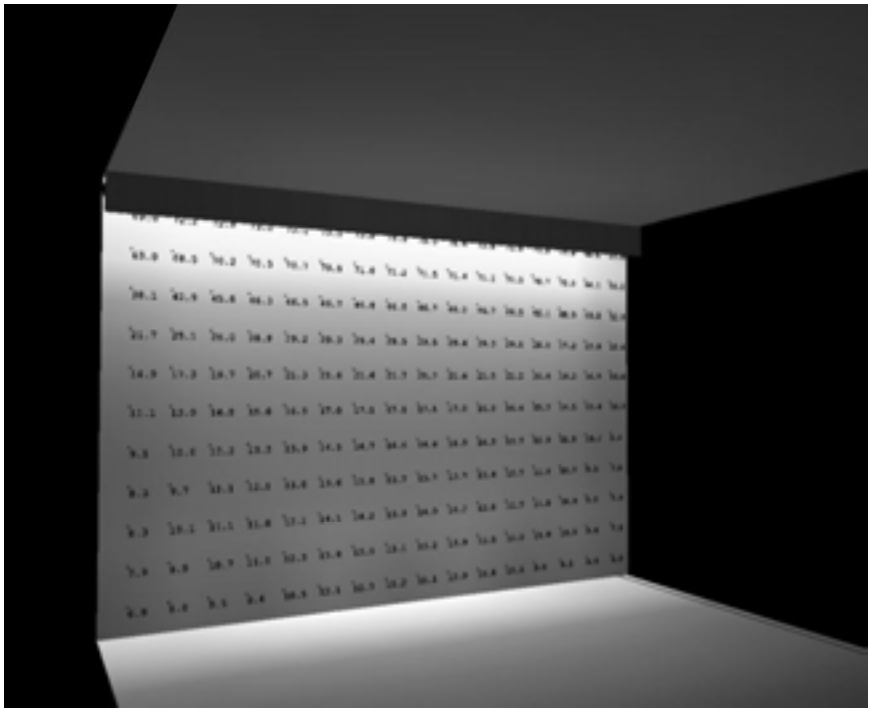
602 lm/ft

71 fc @ 8 ft.

Comparison - Linear Fluorescent Grazing



Philips T5 Fluorescent Cove Light:
TMS122/128 + GMS122R Fixture
TL5-28W, 4000K, 2625 lm

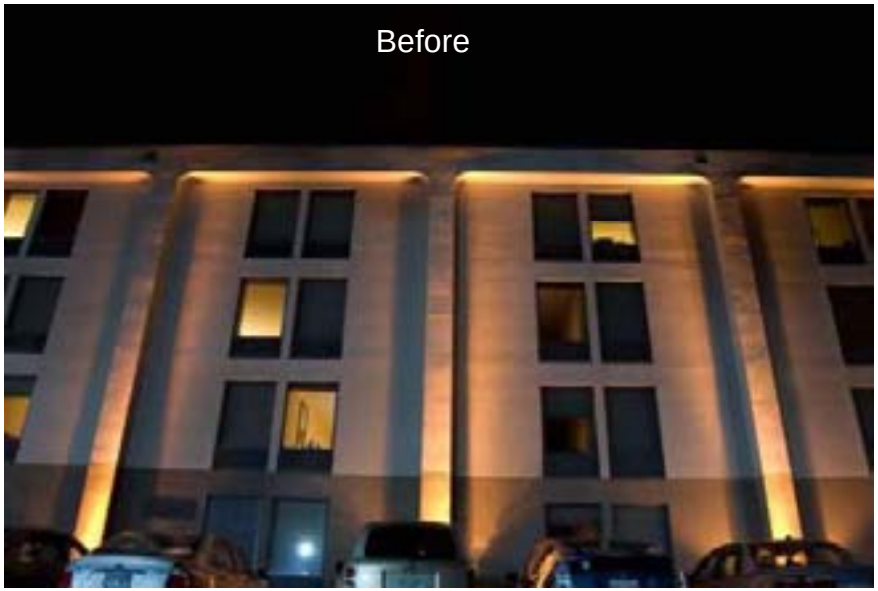


Philips CK LED Cove Light:
eW Fuse Powercore - 10°x60 °
4000K, 600 lm

Evaluating Light Output

...and is the effect that counts !

Desired lighting effect: high-lighted columns on facade





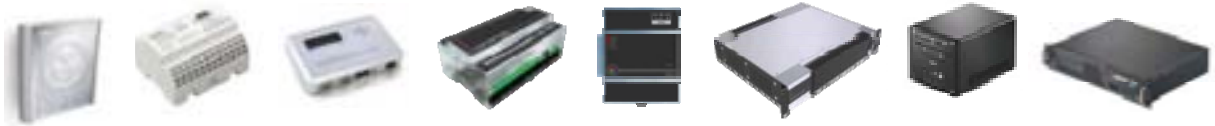
- **Before:** 3x 275W conventional luminaires (250W lamp + 25W ballast)
- **After:** 6x 50W eW Blast Powercore
  - Features
    - Less spill light, lower power, better effect !
  - Benefits
    - Happier guests, reduced energy costs, improved brand !

What Makes a LED System - Building blocks!

User Interfaces



Scene Controllers



Data distribution & Converters (Networking)



Power Data Supplies / Data Enablers



Tools & Accessories & Software





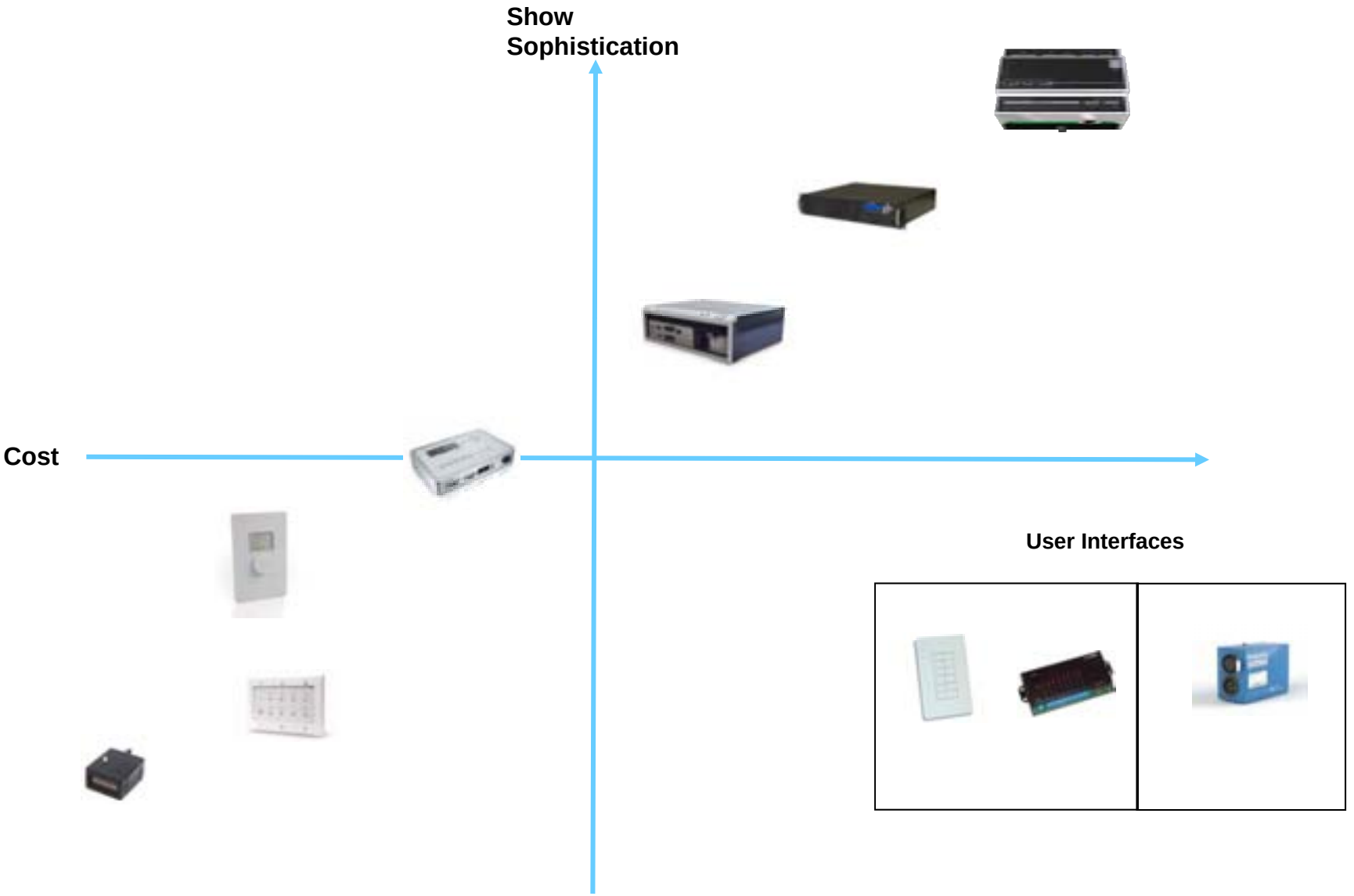




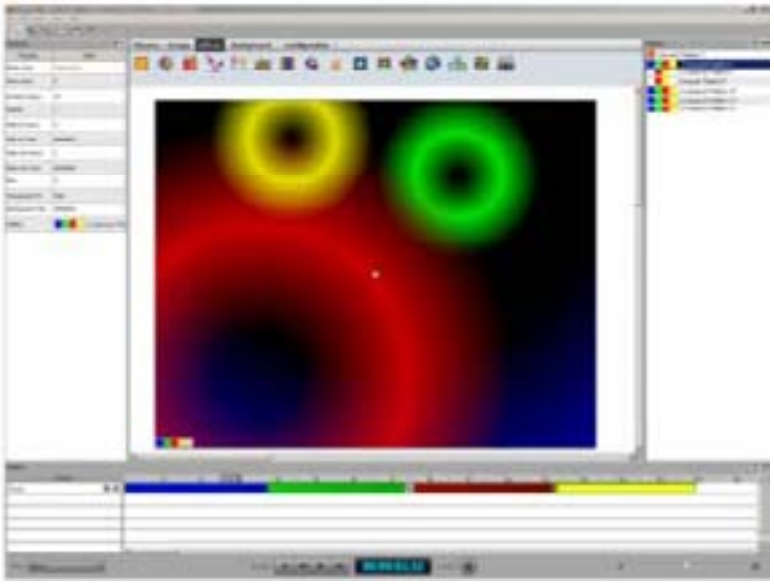
Luminaires

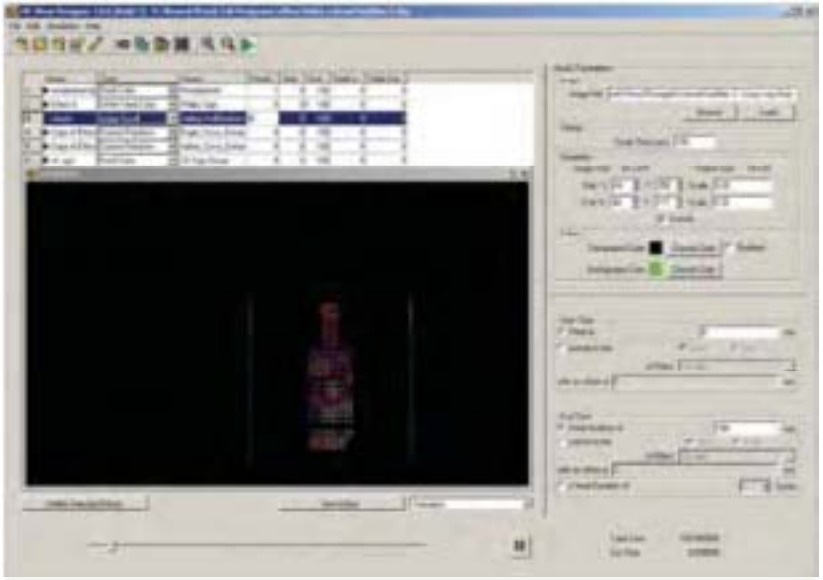


LED Controls Controllers

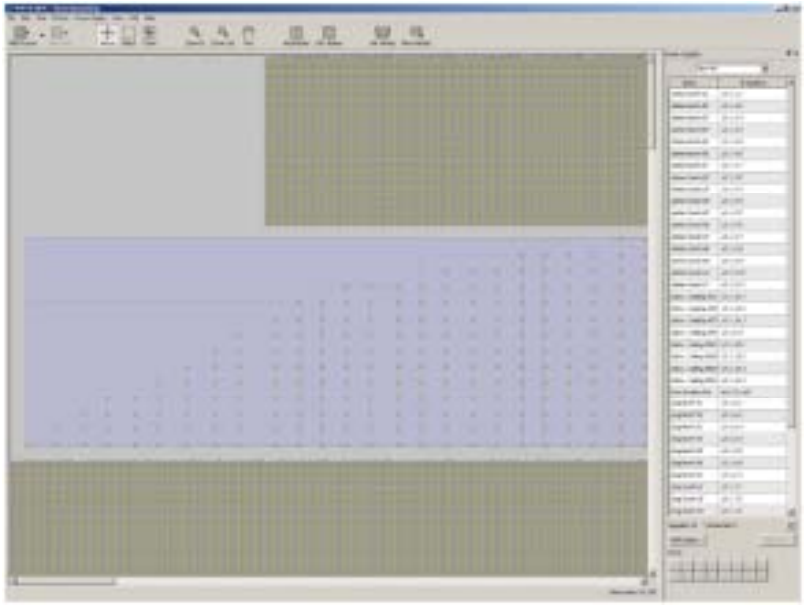


Software



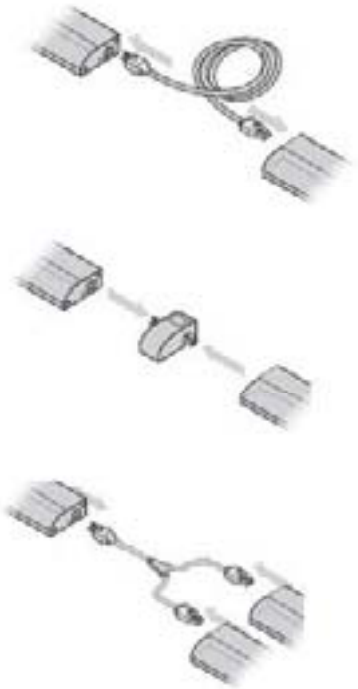


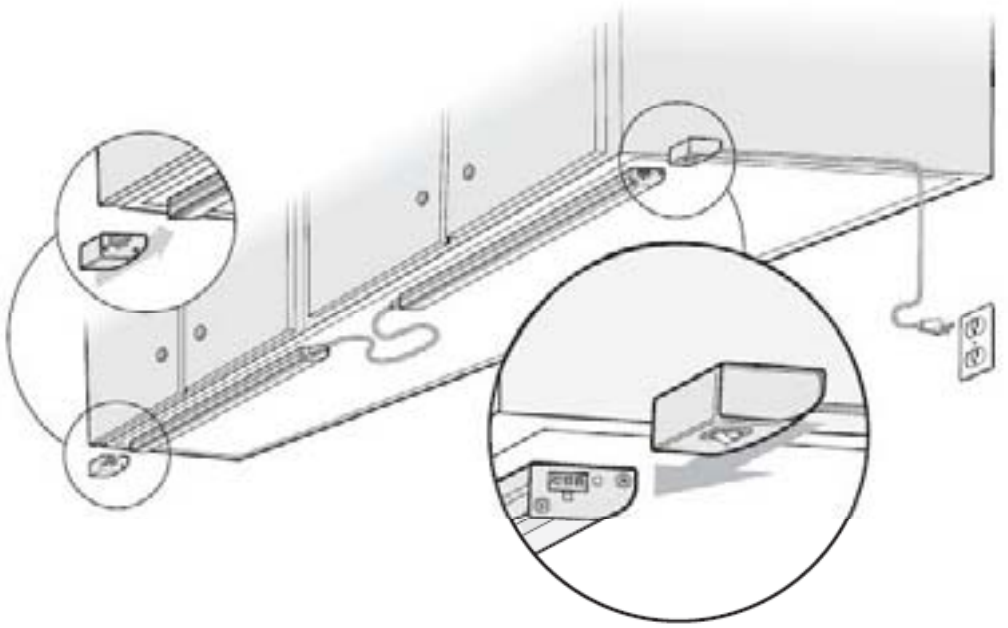


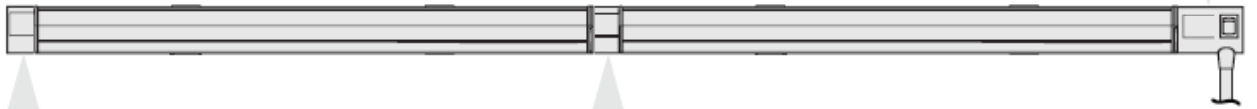


Computer Interface

LED System Example 1
White Light No Control







Switched Leader Cable, Wiring compartment or leader cable

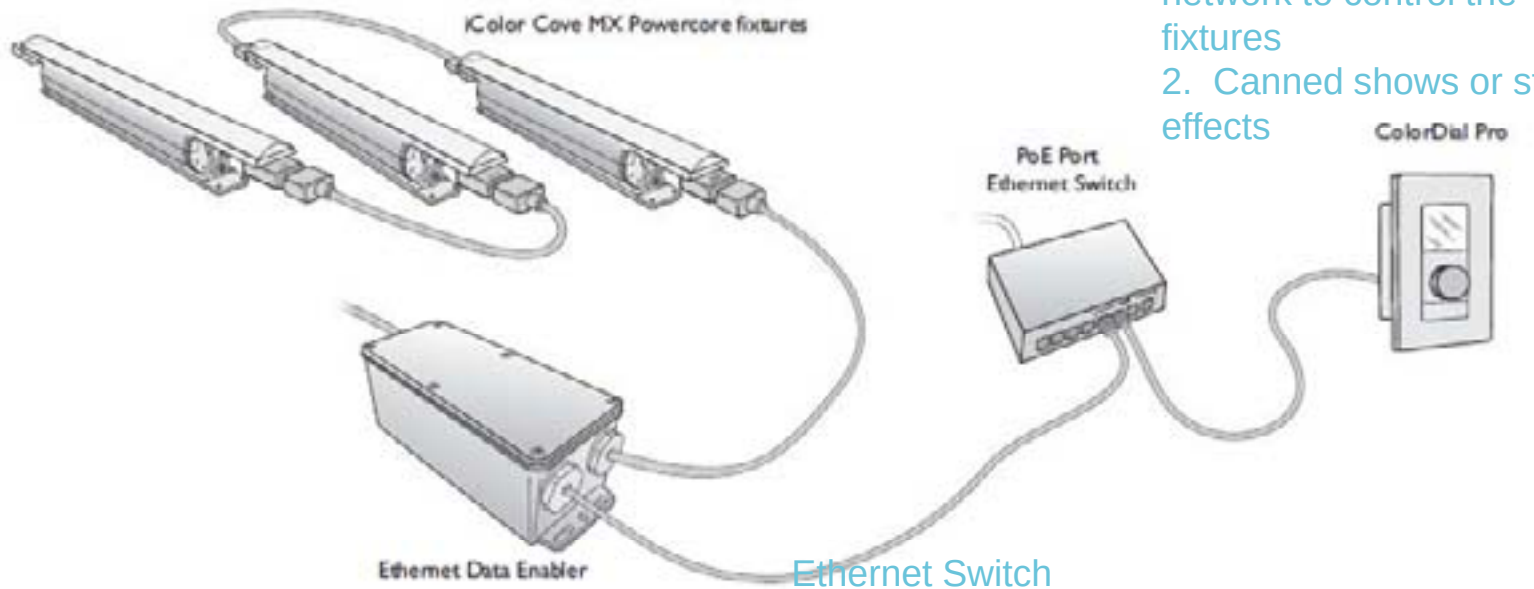
Terminator

End-to-end connector or Jumper Cable
6 in (152 mm)
1 ft (305 m)
18 in (457 mm)
5 ft (1.5 m) or
"Y" jumper cable

LED System Example 2
Color Changing, No Programming

Fixtures
1.Receives power & data from the data enabler which enables the dynamics / changes of colors

User interface & Controller
1. Sends data into the network to control the fixtures
2. Canned shows or static effects



Data Enabler
1.Integrates mains power feed and data into a single 4 conductor cable

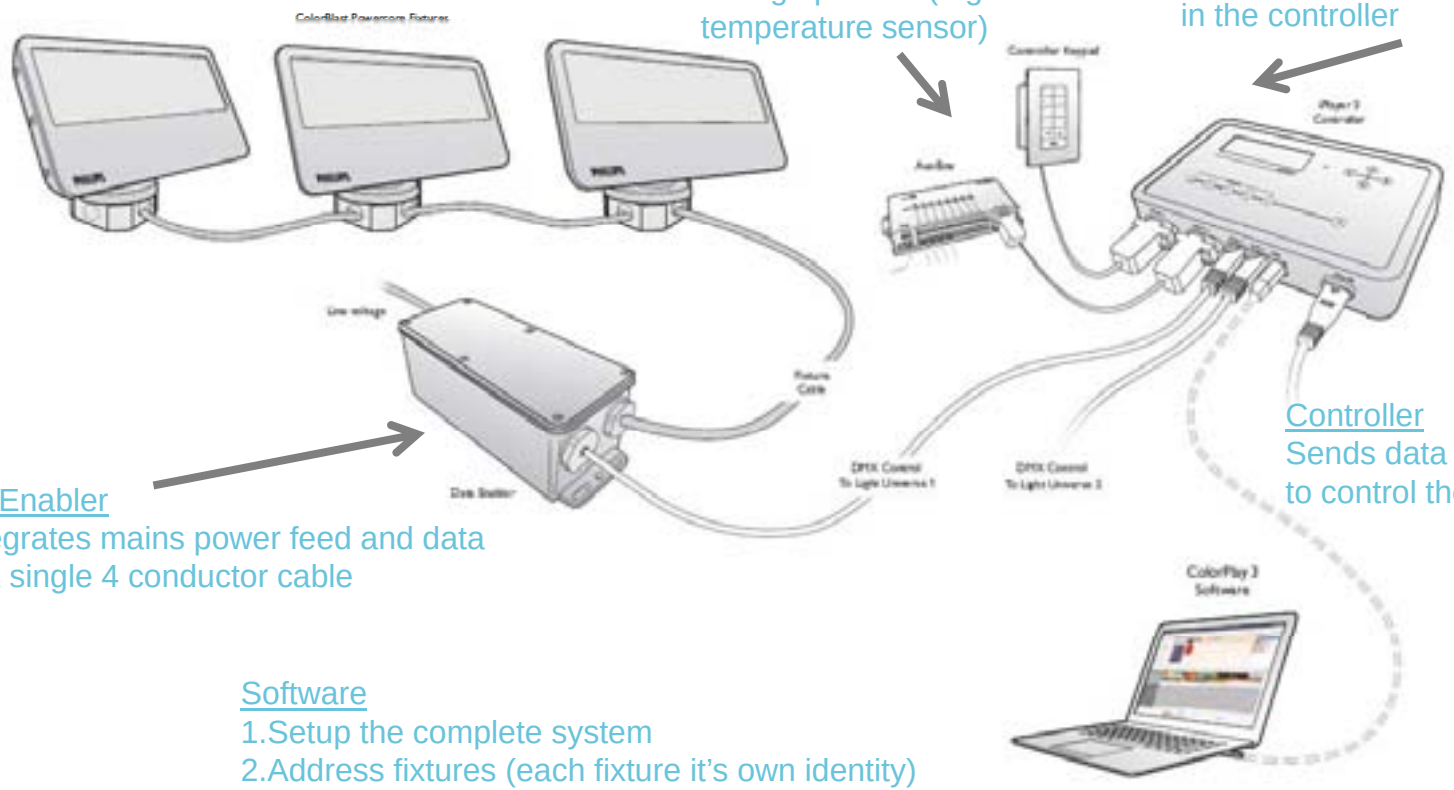
Ethernet Switch
1.Power Supply to the Controller
2.Pass data of the Controller through to the Data Enabler & fixtures

LED System Example 3
Color Changing With Programming

Fixtures
- Receives power & data from the data enabler which enables the dynamics / changes of colors

Accessories
Include an Auxbox to the Controller to receive external triggers and change presets (e.g. temperature sensor)

User Interface
Can trigger from distance the presets that are programmed in the controller



Controller
Sends data into the network to control the fixtures

Data Enabler
1.Integrates mains power feed and data into a single 4 conductor cable

Software
1.Setup the complete system
2.Address fixtures (each fixture it's own identity)
3.Program the different presets

A Color Changing Lighting System's Components

ANATOMY OF AN INSTALLATION



- SITE:

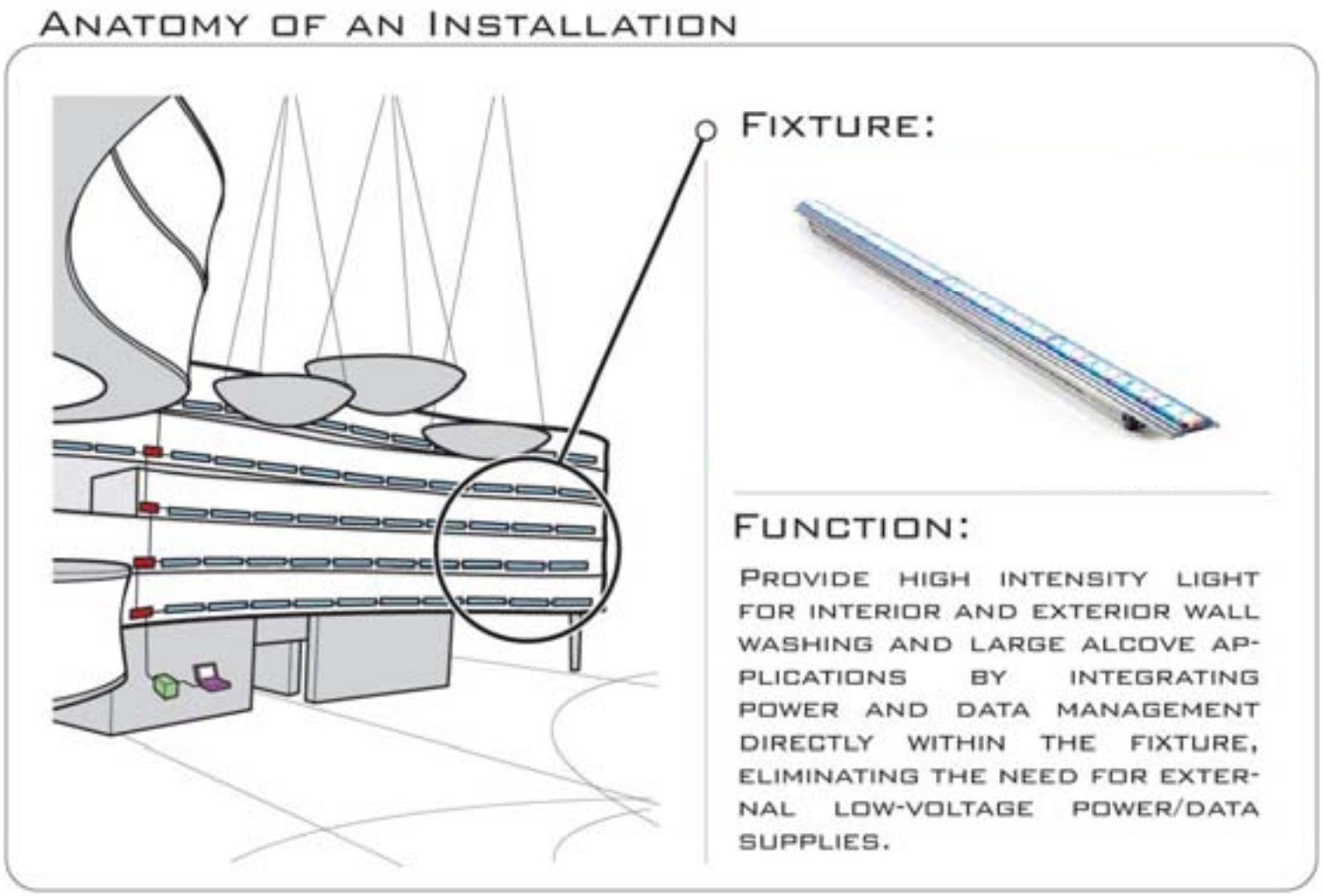


GEORGIA AQUARIUM

FUNCTION:

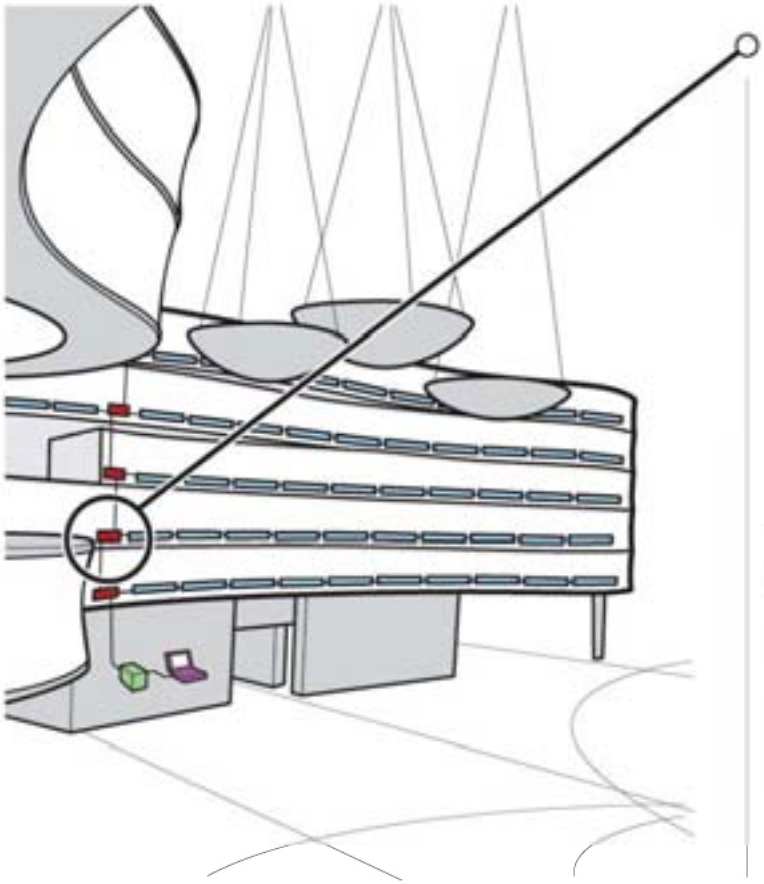
ARCHITECTURAL LIGHTING.

A Color Changing Lighting System's Components



A Color Changing Lighting System's Components

Anatomy of an Installation



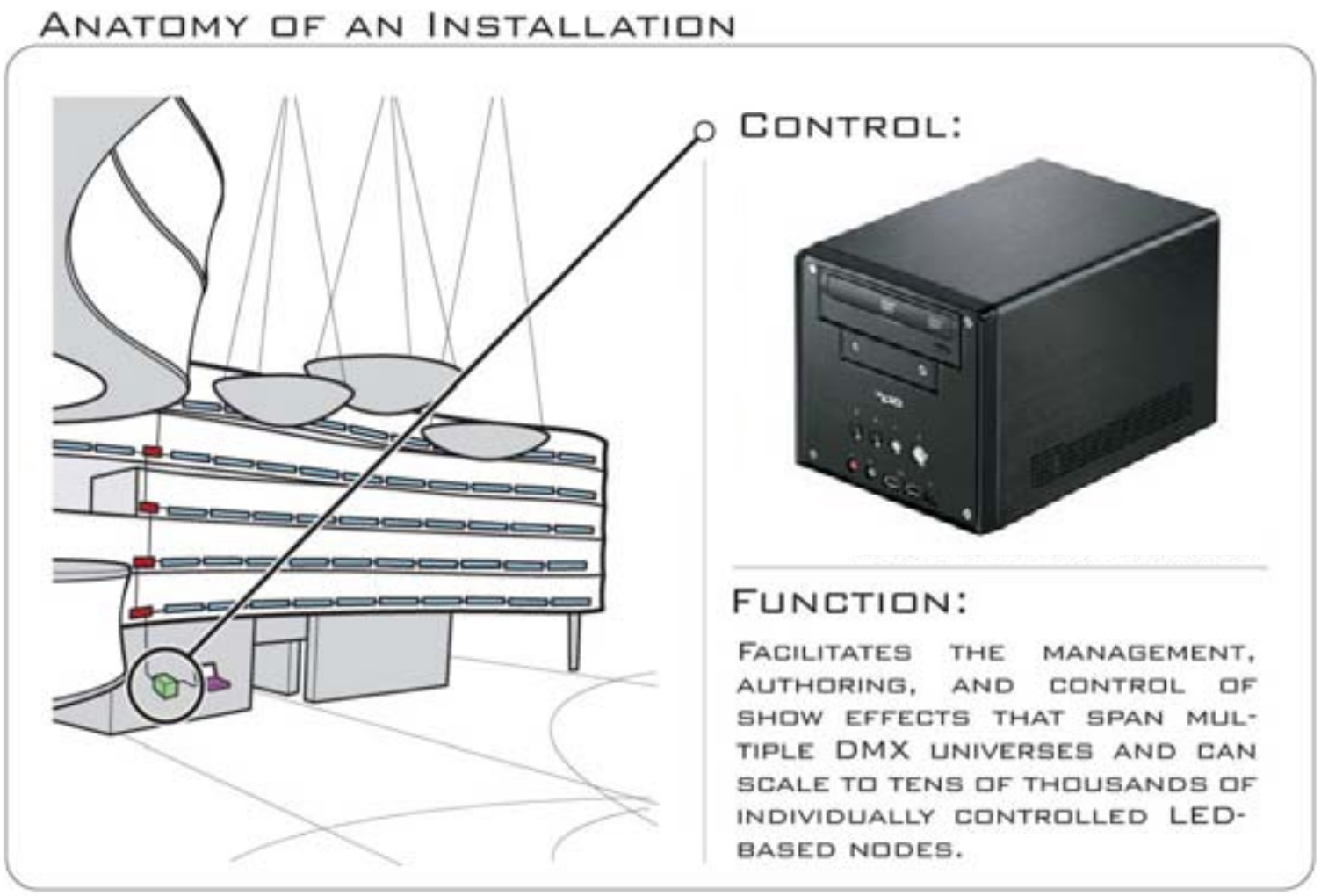
Power/Data Supply:



Function:

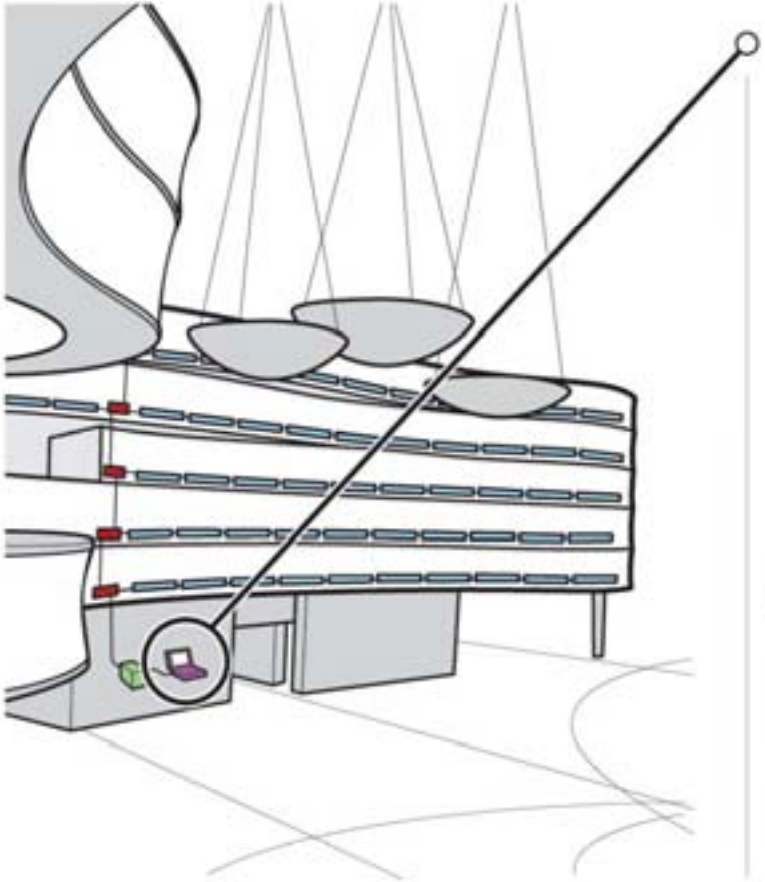
A data formatting power/data supply that relays data from a control device to Color Kinetics products that incorporate PowerCore technology.

A Color Changing Lighting System's Components

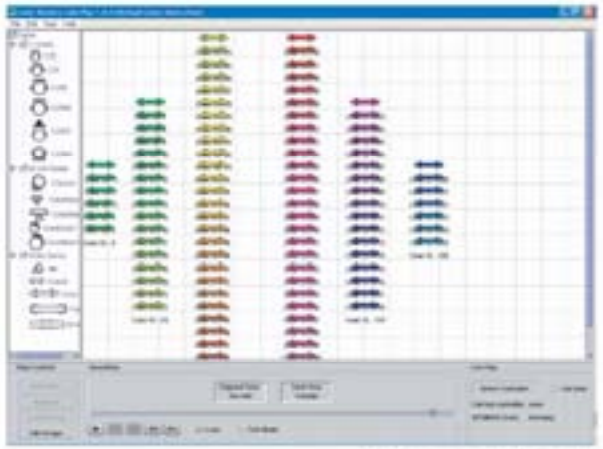


A Lighting System's Components

Anatomy of an Installation



Authoring Software:



Color Play

Function:

Allows users to create shows for any combination of Color Kinetics' lights, by facilitating the creation light mapping, creating timelines, and simulating the show.

LEDs 101

01 Introduction
02 LED Component Basics
03 LED Lighting Application Examples

Old North Church – Boston, MA

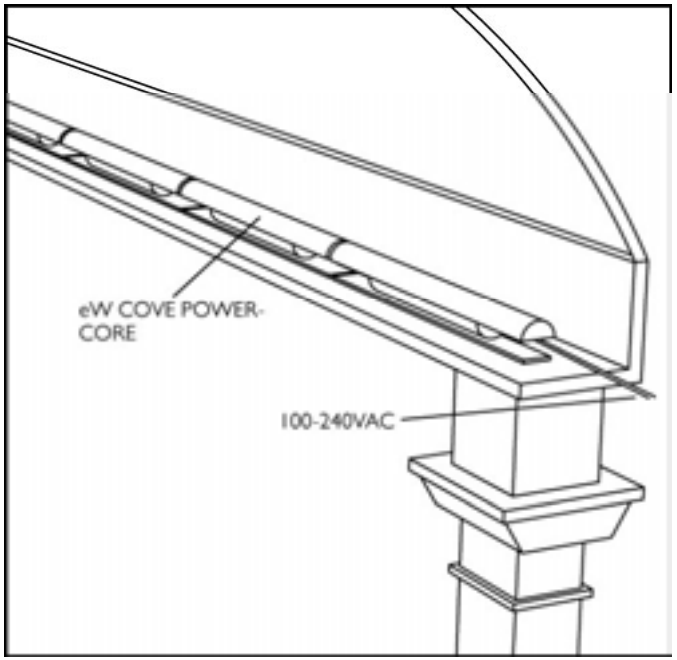
LED Retrofit



Old North Church – Boston, MA
LED Retrofit



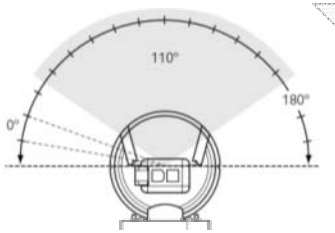




LED Cove Light **70,000 hours L70 @ 77 F**
Lumen Maintenance **50,000 hours L70 @ 122° F**

Old North Church – Boston, MA

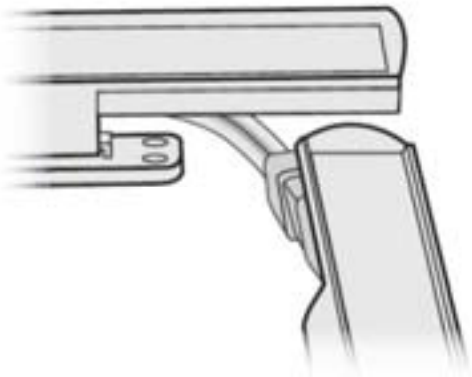






Easy turns

End-to-end locking power connectors can make turns of up to 180° without jumper cables.





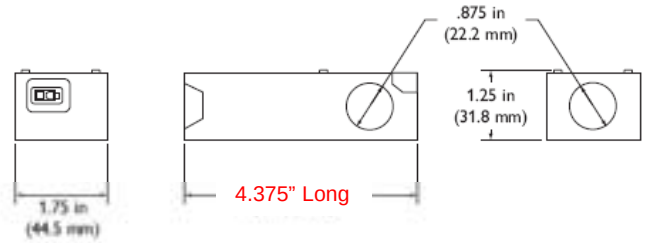
9 Ft

9 Ft

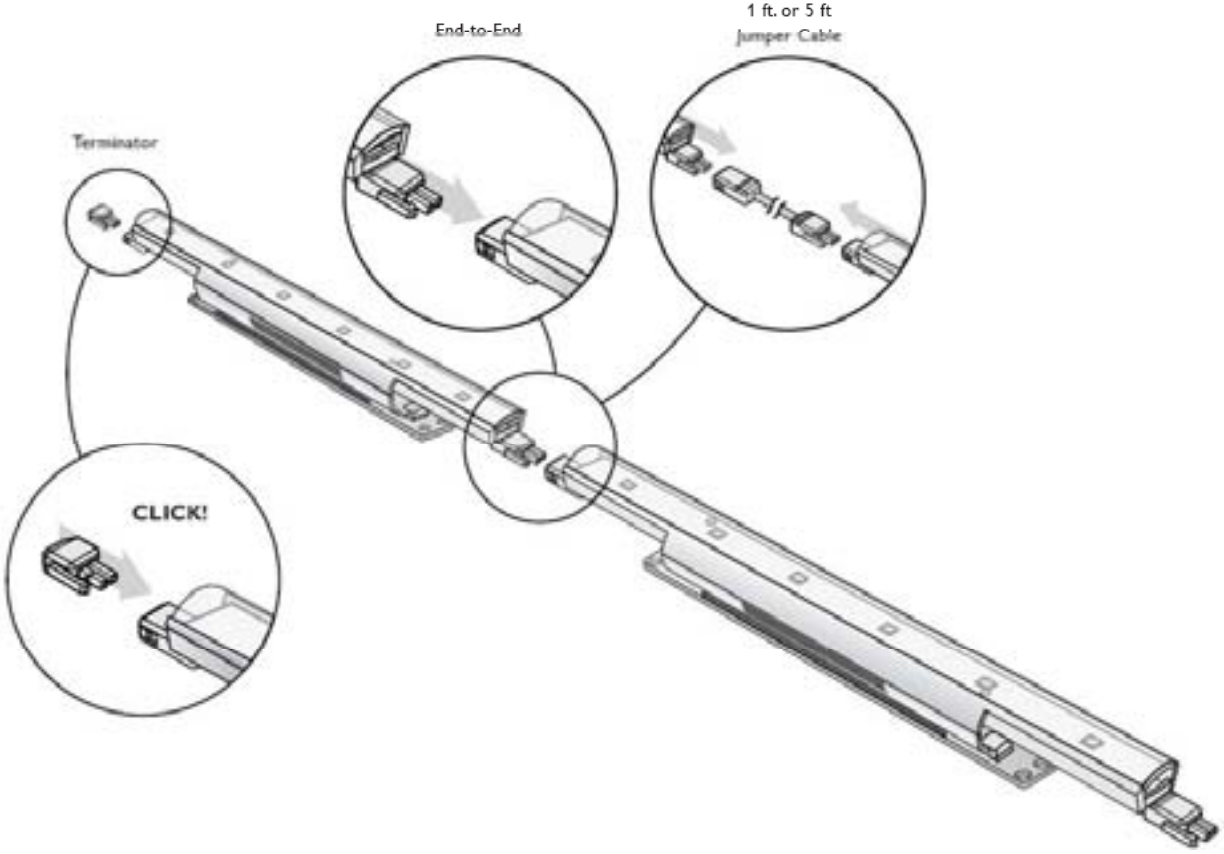
16 Runs

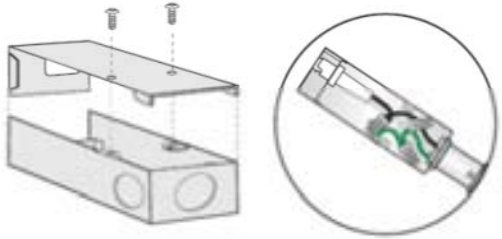
LED Cove Light



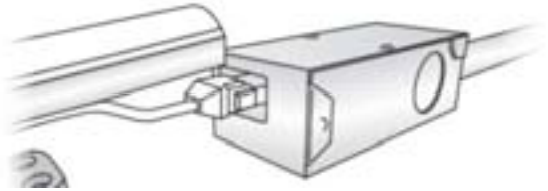








Connect the eW Cove Powercore Wiring Compartment to the first fixture in the series.



Old North Church – eW Cove EC Powercore

LED fixture quantity = 128

Original Incandescent system = 3840 watts

Total system power consumption = 384 watts

Operating Costs

8 hrs x 365 days = 2920 hours

kWh = 1000 watts

LED System = 2920 hours x 384 Watts = 1,121,280 watt hours / 1000 = 1,121.28 kWh x $0.179 = **$200**

Incandescent = 2920 hours x 3840 Watts = 11,212,800 watt hours / 1000 = 11,212.8 kWh x $0.179 = $2007

Difference = Incandescent ($2007) – LED ($200) = $1807

ROI based on $9376 for the complete LED Lighting system, (installed)

- Maintenance cost for incandescent system = $300 per year

  Annual Cost Savings = Incandescent ($2007 + $300) – LED ($200) = $2107

  Total System cost = $9376 / Annual Savings ($2107) = 4.44 Years

The LED fixtures will need to be replaced once the light output is reduced by 30%. If the fixtures were installed in 2008, when will they need to be replaced?

System Life = 70,000 Hours

Operating hours per year = 8 x 365 days per year = 2920 hours

System Life (70,000) / Hours per year (2920) = 23.97 years 2008 + 24 years = 2032

How much money will the Church save over the life of the new LED System?

System Life (23.97 years) – Payback (4.44 years) = 19.53 years

Cost savings per year ($1707) x Total years after payback (19.53) = $33,337.71

Video With Light – LEDs as Pixels



- 50 individually controllable tri-color LED nodes
- Each node powered by Chromasic® for granular control and self-addressing
- Standard nodes spacing is 4” (10.1 cm) or 12” (30.5 cm)
- Custom on-center spacing is available up to 12” (30.5 cm)
- Translucent or clear dome
- Indoor/outdoor rated

Interior Spaces

Condé Nast Cafeteria New York, NY

The corporate cafeteria within Condé Nast's New York headquarters provides a colorful respite from the daily grind. The 12,000 square foot (1,115 square meter) space is architecturally lit entirely by a LED system – no conventional light sources are used.







Aqua

225 North Columbus Drive, Chicago
Height = 819 ft
Floors (OG) = 82
Architect: Jeane Gang
Architect: Jim Loewenberg
Developer: Magellan

Aqua Lighting
LED Fixtures = 4
Beam Spread = 5° and 13°
Total Power = 1140W
Controller = iPlayer3 (fully automated)

LED Fixture Specs
Lumens = 5,20
Color Range = 16.7M
Mixing Distance = 50’
Input Voltage = 100-240VAC
Power Consumption = 290W
Weight = 71Lbs
Dimensions = 20.5” x 28.9” x 4.8”
Life = 90,000 L50 @ 77°F
Temp Range = -40°F - 122°F





South Western Bell St Louis – 22 Stories







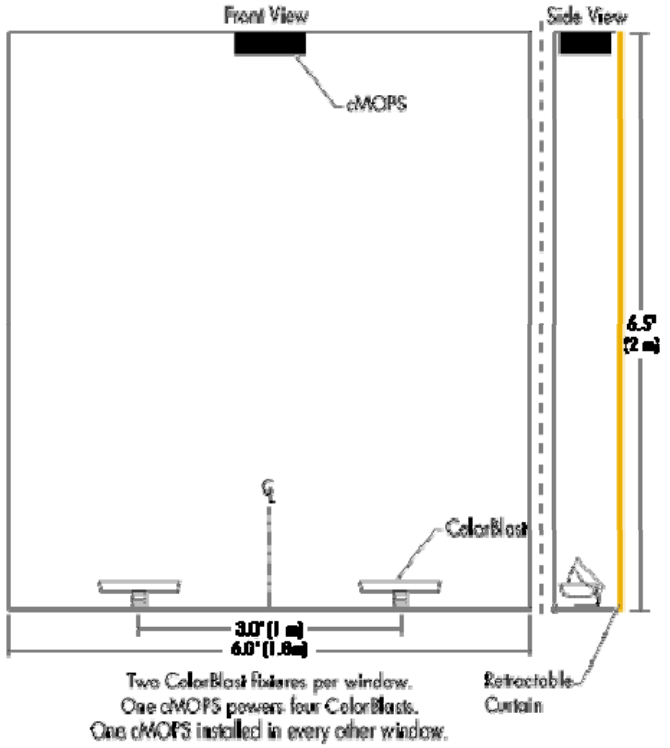
This 60-foot wide section of a 22-story building uses two high power LED spot lights to saturate the sandstone facade with vibrant colors.

The fixtures are positioned 20 feet apart from each other and are set back 20 feet from the exterior wall.

Each fixture uses two lenses – a 13˚ lens on top and 23˚ lens on bottom.

Architecture: Goodman Theatre, *Chicago, IL*



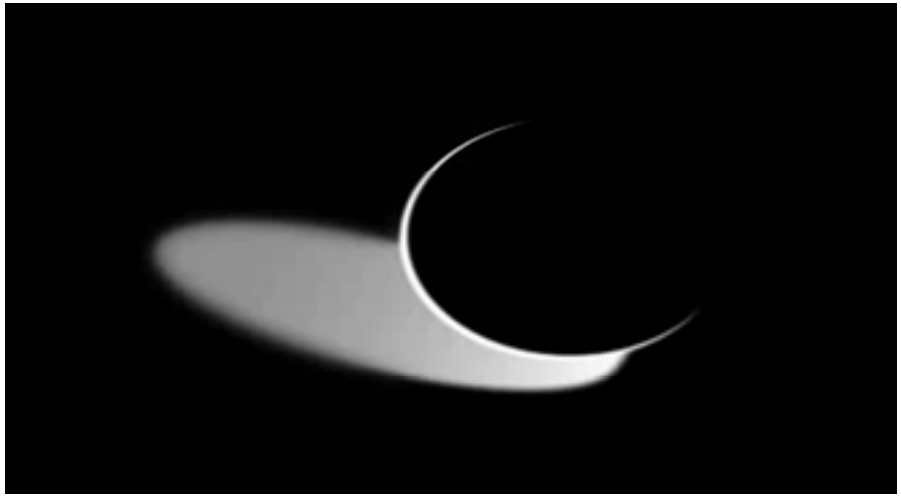






Exterior effects lighting





Potawatomi Casino, Milwaukee

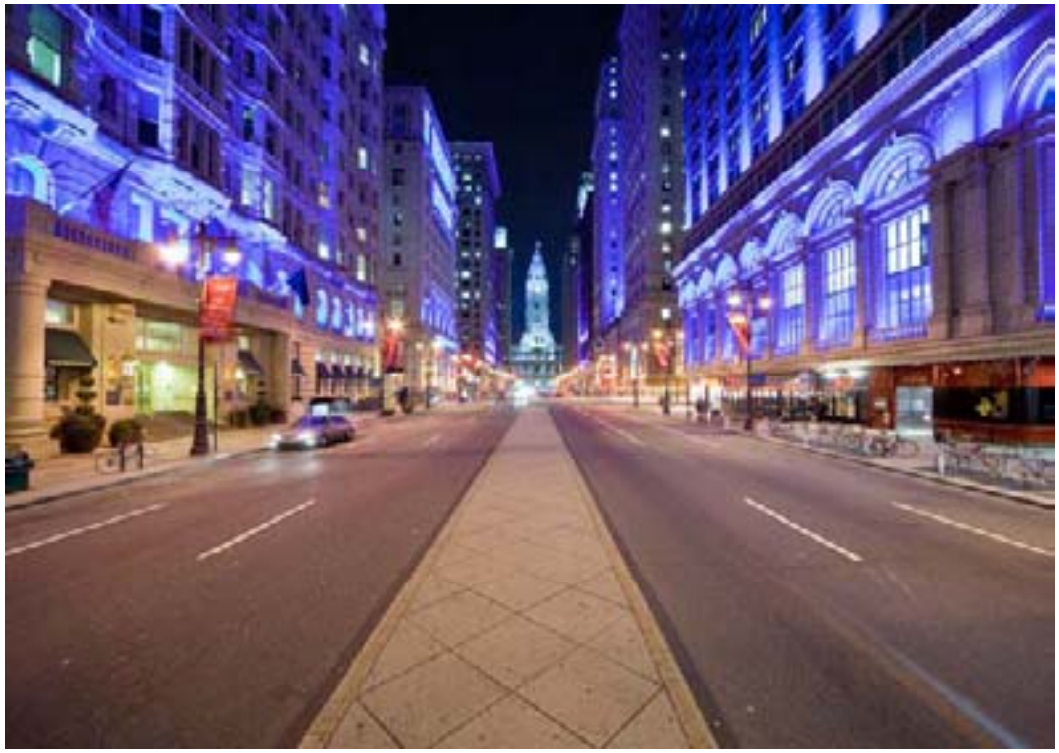
- Design team wanted to create a unique and dynamic entry point to the casino
- The “welcome wall” measures 62 by 123 feet and is comprised of aluminum and frosted glass panels that are
- Lighting effects simulate fire with embers, rain, lightning, stars, the northern lights, and abstract images

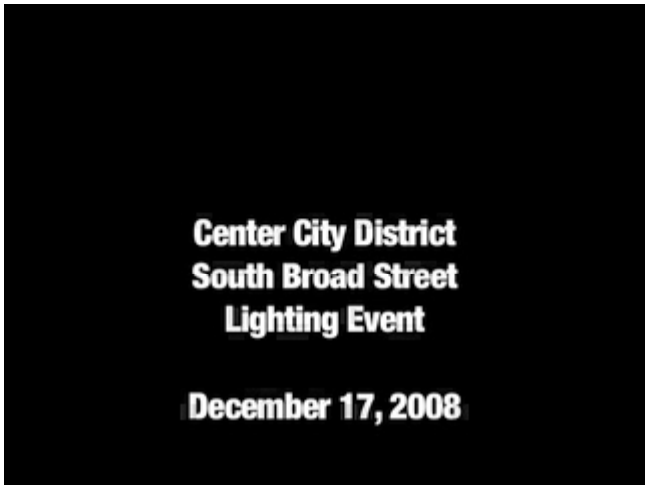


Architectural Lighting



Exterior effects lighting







Philadelphia's Avenue of the Arts

- Illuminated 12 historic facades, including the 550 foot City Hall tower
- All of the fixtures across all of the buildings were synchronized to produce one cohesive light show set to music, controlled by one LSM

Architectural Lighting





Photo Credit: MF3 Photography



Grazing

Architectural highlighting

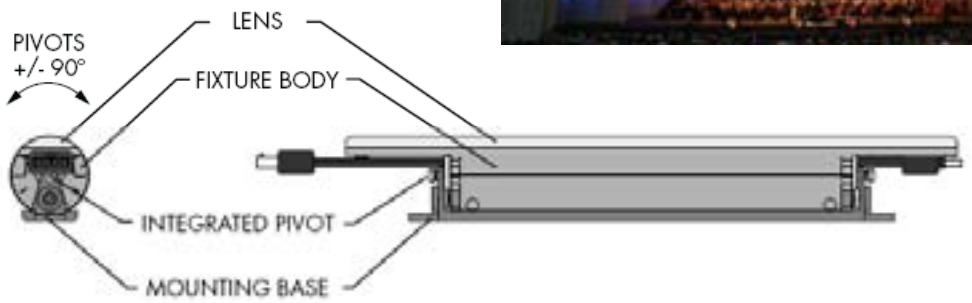
Theatrical: *Hollywood Bowl, California*











Amusement: London Eye, London England



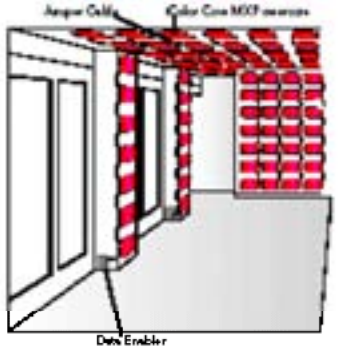
- 1040 RGB LED fixtures
- Astronomical triggers ensure automated day-to-day operation
- Realtime clock triggers provided accurate participation in the New Year’s firework display
- The Pharos LPC’s web server provides manual control via a custom web interface

Interactive Display:

Target Breezeway at Rockefeller Center New York







High atop New York's Rockefeller Center is a unique, interactive space that takes the capabilities of intelligent LED lighting to new creative heights.

The Target Interactive Breezeway is an imaginatively lit passage that connects the Center's top-floor observation decks. Its intention is to engage visitors as they pass through by tracing their movement with intelligently controlled light.

Kinetic Interior Lighting







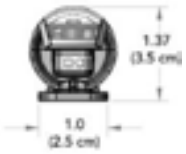
Kinetic Retail Lighting



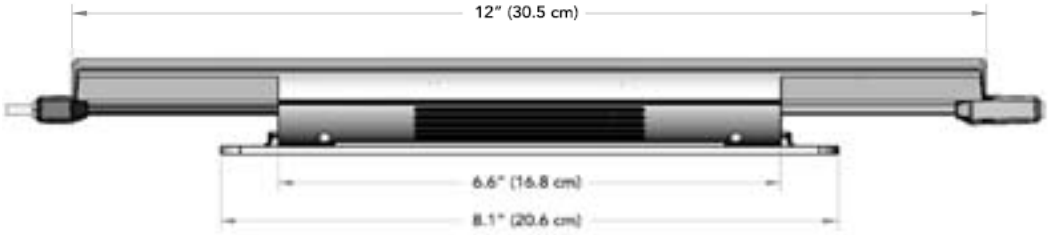




Lighting magazine's March issue featured an LED installation at Lacoste, a sports apparel retailer, which utilizes LED color changing Cove lighting in a number of boutiques throughout the U.S. and in Europe.







Case Study: Harrah's Resort & Casino

- Wanted to stand out from its Atlantic City neighbors
- Created world's largest outdoor video display by covering the façade of its 44-story Waterfront Tower
- Over 4,500 linear LED fixtures (almost 6 linear miles) wrap the building's four sides



Harrah's Resort, Atlantic City, New Jersey
Photo: Tim Hunter Design

Case Study: Harrah's Resort & Casino continued…



Harrah's Resort Waterfront Tower, Atlantic City, New Jersey
Photo: Tim Hunter Design

Architectural Grazing & Point Source Lighting







For more information….



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