

The Force of Light

FORZLUX



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Corporate Presentation
August 2019

What Does Forzlux Mean?

- Latin word FORZA means FORCE
- Greek word LUX means LIGHT
- Forzlux means
 - The Force of Light
 - We dropped the “a” in forza
 - Forzalux is a hotel in Montenegro
 - www.forzalux.com was taken
- Forzlux = www.forzlux.com
- The name is appropriate.
- Forzlux is fascinated by the **impact** (force) that our manufactured **light** has in **bringing smiles** to customers when we mutually create beautiful luminaires with amazing performance.
- Forzlux customers can attest to impressive success stories in lighting applications
 - Landscape
 - Food Processing and Inspection
 - Theatre
 - Florida and Hawaii Turtle Friendly



About Forzlux

- Manufactures electronic lighting components and systems
- Sells B2B direct ONLY to OEM luminaire manufacturers, no distributors
- Provides LED modules, drivers, controls, optics, and technical support
- 100% of LED modules manufactured in Santa Ana, California
 - Rapid order fulfillment
 - Superior service and communication
- Minutes from John Wayne Airport (SNA), Disneyland, and O.C. beaches
 - Customers encouraged to visit and tour facility
- Officially commenced 2019, however LED/lighting DNA dates back to 1995
 - Owns the industry's oldest patents (1999) for LED on metal board
- Forte is designing, developing, and rapid delivery of high performance customer specific products for unique lighting applications
- Customers treated like partners
 - Actively engaged with customers under MNDA to become an extension of their lighting technology team



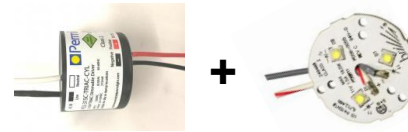
Forzlux Value Added Services

- No Cost Collaborative Engineering
 - Luminaire prototype and retrofit, thermal, and power consumption test
 - 60" Integrating sphere measures total lumens, CCT, and CRI (not IES file)
 - Assistance with UL/CSA/ETL, ENERGY STAR, DLC, LM-80, TM-21
 - Consultation and compatibility testing of drivers and dimming controls
- Stock SKUs and normal lead times
 - Large stock of PCB (bare boards), LED in popular CCT, and drivers
 - Modules and engines are built to order due to large variety of SKUs
 - Typical 2 weeks shipment for popular SKU
 - Drivers typically stock
 - Typical 8 weeks shipment if no stock, can recommend alternatives
- Terms of warranty to meet 5 year DLC requirement
 - OEM must comply with datasheet thermals, handling/warranty guidelines
 - When in doubt, Forzlux can test customer fixture at no cost to verify



Forzlux Typical LED Engines, Line Voltage 120-277VAC

- Driver and module engineered for compatibility and warranty
- Point source (down light, pendant, sconce)
 - 450 lumens, 3W, 120VAC, triac (incandescent) dimmable
 - Replaces 60W incandescent bulb
 - PS3-315C-TRIAC-CYL + BBO3FK



- Linear source (linear architectural, cove, low/high bays)
 - 1800 lumens, 12W, 120-277VAC, triac (incandescent) or 0-10V dimmable
 - Replaces 32W fluorescent tube
 - PS14-350C-DUALDIM-UNV-P + BB22TM



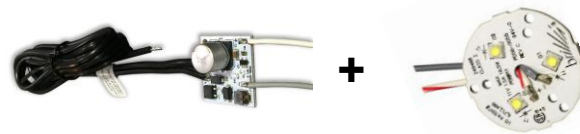
- Rectangular source (wall pack, flood)
 - 7000 lumens, 45W, 120-277VAC, 0-10V dimmable
 - Replaces 150W metal halide lamp
 - PS50-1050C-DIM-UNV-TL + BB42WC



Forzlux Typical LED Engines, Low Voltage 8-18VAC/DC

- Driver and module engineered for compatibility and warranty
 - Ideal for 12-15VAC magnetic (landscape) transformers
 - Replaces 20-50W MR11, MR16 halogen
 - 150-600 lumens, 1-4W, 8-18VAC/DC, LVM dimmable
 - Available in waterproof versions, encapsulated, and with IP67 connectors

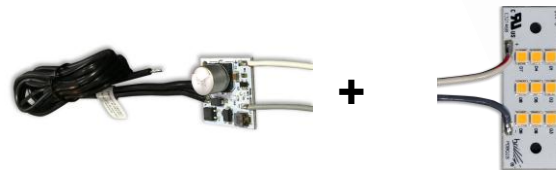
- Point source (landscape, track head)
 - PS11-450C-818-1 + BBO3FK



- Linear source (step, path, wall lighter)
 - PS11-450C-818-1 + BB12LL



- Rectangular source (step, flood)
 - PS11-256C-818-1 + BBO9BU



Surface (Shallow) Engines

- Forzlux can create a custom engine exactly to requirements
- For flat format “pan” luminaires
 - Sconce, downlight, pendant, ADA
 - 1,000 – 4,000 lumens, 7 – 25WDC
 - Diffused/soft appearance over entire lens surface
 - Integrated white driver reduces shadows, eliminates j-box mounting
 - No heatsink required for interior applications up to 40°C
 - Double power/lumens with remote driver(s) and proper heatsink
- Standard available sizes and shapes
 - BEP54SR = rectangle 4.25 x 8.25”
 - LED Retrofit Luminaire Conversion Kit, UL 1598C, Classified
 - Field settable power : 7W, 11W, or 14W
 - BEP40JR, BB40JT = rectangle 4 x 6”
 - BEP40HR = half round 9.25”



BEP54SR



BEP40JR

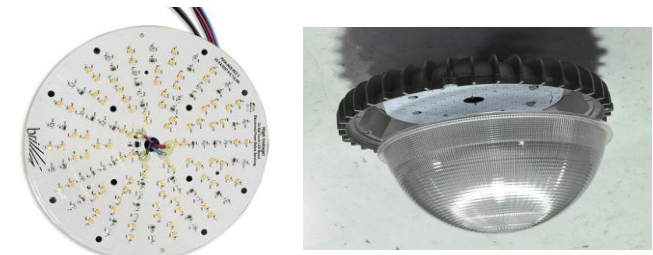
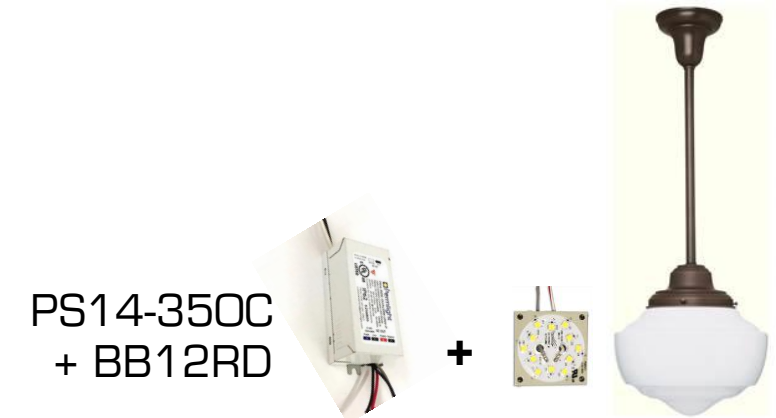
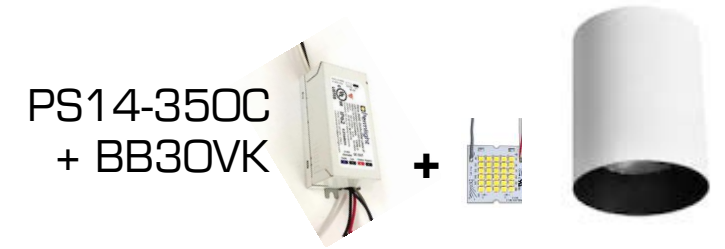


BEP40HR



Point Source Engines

- Forzlux can create a custom engine exactly to requirements
- For classic round format luminaires
 - Sconce, downlight, pendant, low/high bay, garage
- 450 – 30,000 lumens, 3 – 180WDC
- Wide range of power and CCT/CRI
- Remote driver and heatsink required
- Standard available sizes and shapes
 - BB30VK = 1.38" square, replaces Vero18 COB
 - BB12RD = 1.6" square, round LED pattern
 - BB14RC = 2.17" square, 0.41" hole for shafts
 - BB33UP = 3.5" round, 1.25" hole for shafts
- Custom modules = 8 - 14" round, for garage, low/high bay



Linear and Rectangular Engines

- Forzlux can create a custom engine exactly to requirements
- For linear or rectangular format luminaires
 - Bollard, wall pack, low/high bay, linear architectural, garage
- 3,600 – 30,000 lumens, 24 – 180WDC
- Wide range of power and CCT/CRI
- Remote driver and heatsink required
- Standard available sizes and shapes
 - BB12TB = 0.44 x 5.7", 4 modules replace 100W metal halide
 - BB66WA = 1.6 x 9.25", replaces 100W metal halide
 - BB90WB = 2.3 x 9.25", replaces 150W metal halide
 - BB48T0 family = 0.5" wide, 5.125" long through 23.5" long
- Custom modules = 0.5 x 44" for garage, low/high bay



PS14-350C + (4) BB12TB

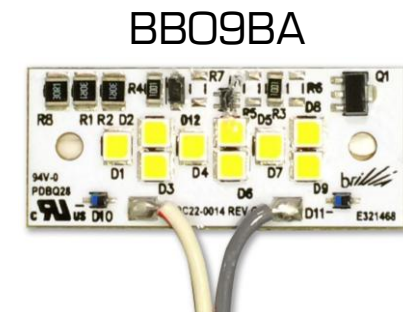
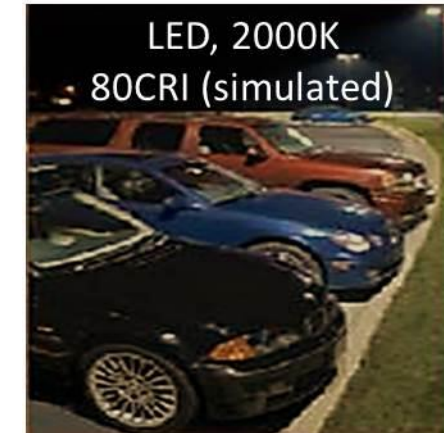


PS50-1050C + BB66WA



Unique Application Engines

- 2000K CCT “amber” Modules (not Turtle Friendly)
 - Replaces HPS with same “warm” look
 - Cool white LED is “stark” and high glare
 - CRI 80 vs. 22
 - Solves issue “dude, where’s my car?!”
 - Also ideal for decorative applications to simulate dimmed incandescent or candle color
 - Available on virtually all Forzlux modules
- Thermadjust™ Module
 - For exterior fixtures with limited heatsink
 - Automatically dim if heatsink is insufficient “Air bags for LEDs” or “LEDs for dummies”
 - Constant Voltage 12VDC for easy driver sourcing and paralleling of multiple modules on one driver

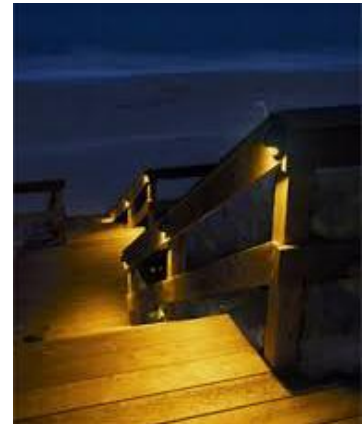


Monochromatic Modules

- Monochromatic colors available on most modules
 - Red 630nm and/or green 525nm and/or blue 470nm
 - LEDs can be mixed to create orange, purple, pink, etc.
 - Ideal for signs and specialty applications such as carwash
 - This is not RGB color changing, only fixed (single color)



- Turtle friendly amber available in several size modules
 - Florida Wildlife Commission (FWC)
 - Strict low intensity, wavelength <600nm, no blue content
 - “PC amber” LED will fail test due to blue content
 - Hawaii has similar rules, less than 2% blue content
 - Compared to white LED, 595 amber is 5x cost and 1/4 lumens but very long wavelength, example fog lights
 - For non-turtle friendly application, use lower cost 2000K (previous slide) which looks like amber



Optics and Lenses

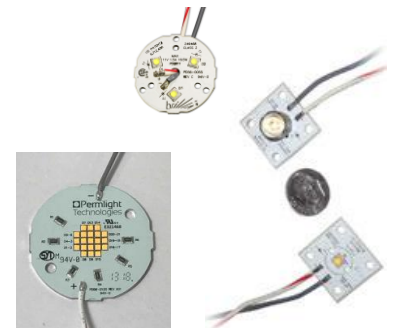
- End users becoming increasingly concerned with reducing glare
 - Optics have dramatic effect on luminaire efficacy
 - Optics can partially block, diffuse and/or focus LED intensity
 - Light transmission options from 50-90%
 - Forzlux recommends customers purchase optics from Ledil
 - Forzlux can assist with design and create compatible LED module
- Forzlux standard lenses
 - 3" diameter dome, compatible with < 3" diameter LED modules
 - 96" long linear, compatible with 0.5" wide LED modules
 - Can be cut to any length
- Modules designed for use with off-the-shelf Ledil optics
 - Designed for shaping and/or directing beam to achieve lighting targets
 - Available in wide flood, medium and narrow
 - Attached by screws or silicone
 - Examples: HEKLA/BROOKE/BARBARA, LISA, GT-3



3" Dome lens



96" Linear lens
cut to length



Modules accepting
LEDIL optics

The Force of Light

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Presentation for Geeks

(If you're busy, proceed no further...)

August 2019

Driver FAQ

- Forzlux LED modules are compatible with industry drivers if current/voltage ranges met
 - CRITICAL! Driver DC OUTPUT VOLTAGE RANGE must match module voltage
 - Incorrect driver will strobe or worse... shorten driver life without visual indication!
 - Forzlux can test other manufacturer's drivers for compatibility and warranty
- Dimming drivers are compatible with most dimmers and occupancy sensors
 - Generally, AC input or dimming on driver has no detrimental affect on module
 - No loss in LED or driver lifetime by repeated on/off cycling or dimming
- Driver datasheets can be misleading, no ratings over temperature and load
 - Drivers specified by DC OUTPUT WATTS, not power consumption
 - Driver DC OUTPUT CURRENT must be less than or equal to rating of module
- It is safer that multiple modules are run in SERIES, not PARALLEL
 - LED voltage variance can cause current non-sharing and premature failure

Miscellaneous FAQ

- What's the difference between constant voltage (CV) and constant current (CC)?
 - CV is best for long runs, illuminated sign or cove lighting, loses 10-25% efficacy, completely scalable, multiple modules can be run in parallel
 - CC is best for a single fixture, highest efficacy, not always scalable, multiple modules can be run in series or share the current in parallel
- Are your LED light engines wet listed?
 - OEM fixture must be wet listed, components do not have to be
 - Most drivers and modules are damp recognized
 - For exterior operation, a transparent conformal coating Humiseal IB31 is used to minimize corrosion in the event of moisture/condensation forming inside fixture. The material is high temperature, UV resistant, won't change color and doesn't trap heat of LED. It is not "waterproof", just "water resistant".
 - For landscape or submersed fixture, the engine can be encapsulated with a clear epoxy to be completely waterproof, only with "dome" LED to prevent CCT shift

Dimming LED Modules

- Technically... LEDs do not dim, the DRIVER does the dimming

- DIMMING TYPES AND APPLICATIONS:

- Residential and commercial
 - Triac (incandescent, forward phase) or 0 - 10V dimmer
 - Example: PS14-350C-DUALDIM-UNV-P



- Commercial low power
 - ELV, electronic low voltage (trailing edge/reverse phase)
 - Example: PS3-350C-DIM



- Landscape or track low voltage
 - LVM, low voltage magnetic dimmer
 - Dimmer on AC side of magnetic transformer
 - Example: PS11-450C-818-1



- Commercial high power
 - 0 - 10V dimming
 - Example: PS50-1050C-DIM-UNV-TL

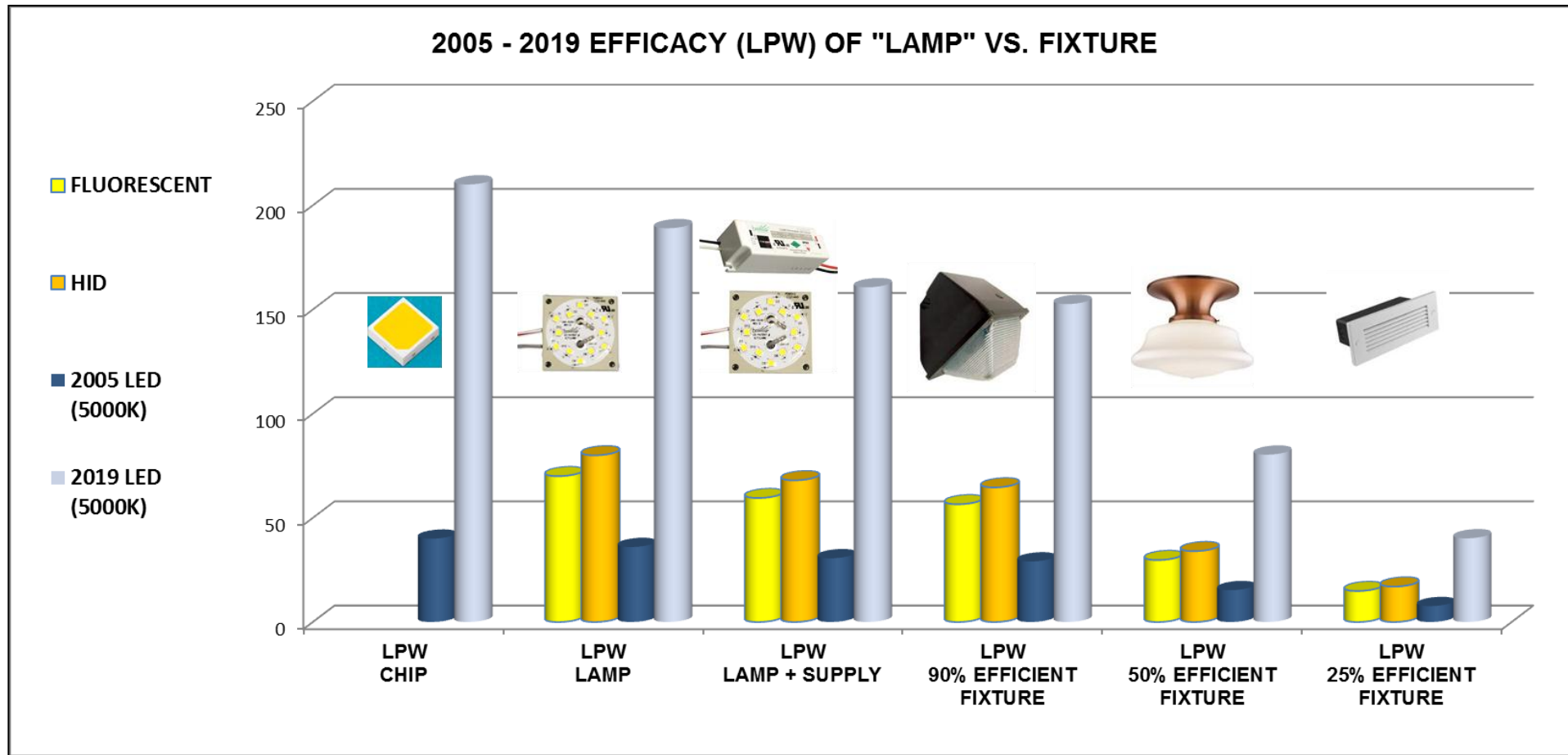


Thermal and Handling

- Thermal recommendations
 - Heatsink must be in intimate contact to outside air (not a couple of screws)
 - Ideally, module should be mounted directly to fixture's metal housing
 - Recommend 8 sq. inches per watt of 16 gauge aluminum (0.060" thick)
 - Do NOT use thermal grease, can contaminate LED
 - 3M 468 tape is better than attaching to a heatsink that is not flat or has burrs with screws/rivets because air gaps
 - Air pockets have the worst thermal conductivity
- OEM handling recommendations that could void warranty
 - Don't touch or push down on LED or scratch top of PCB
 - Don't modify or cut module, solder wires or cut wires close to PCB
 - Use torque values on datasheet and pan head screws if specified
 - Don't use flat head (cone shaped) screws, can cause short
 - Modules with 3M 468 tape: clean heatsink with alcohol only, no chemicals
 - Do not "hot swap": attach module to driver FIRST, THEN driver to AC



LED Efficacy (Lumens Per Watt) in Various Fixtures

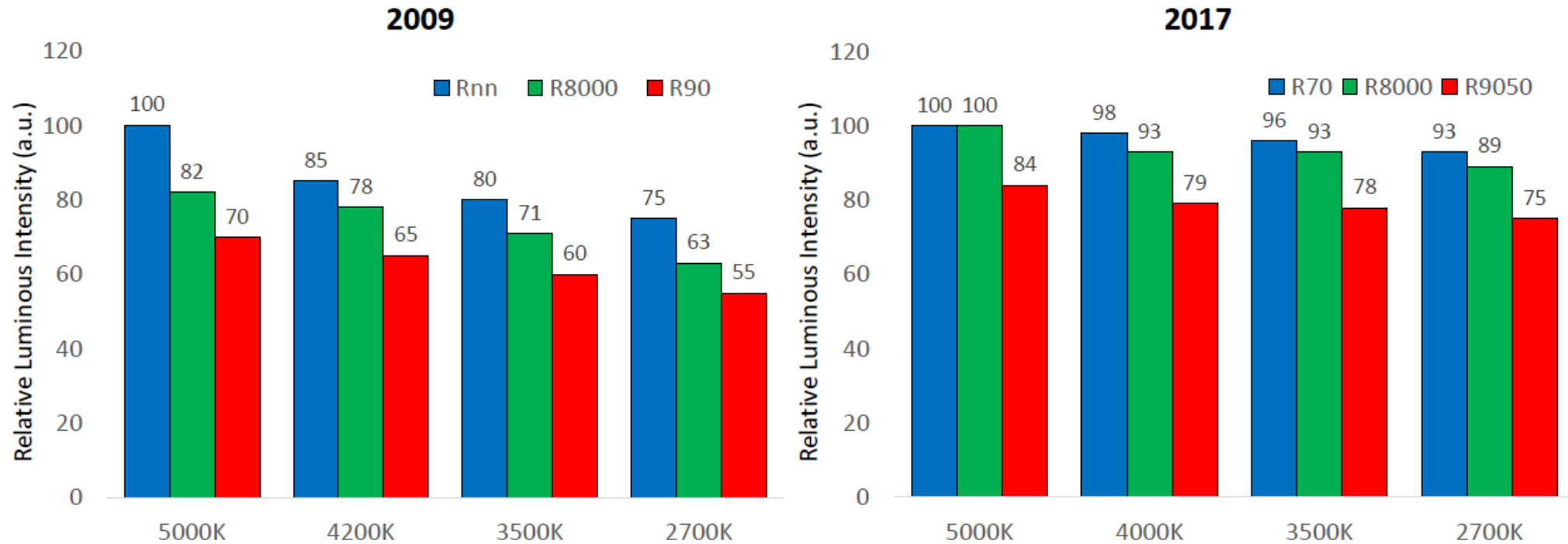


Rule of Thumb:

2019 LED replaces fluorescent or HID with about 35% of power

LED Efficacy (LPW), Impact of CRI (Color Rendering Index)

CCT/CRI vs. Luminous Intensity



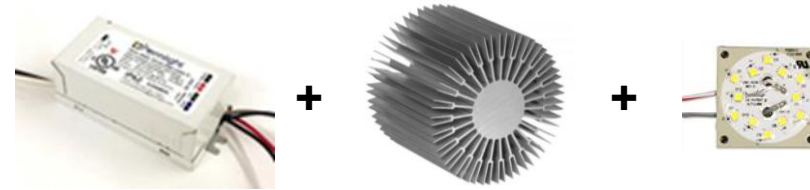
- Low CCT and high CRI require more light from phosphor.
- Luminous Intensity is down due to Stokes loss

Forzlux Part Number Key

LED Light Engine

Defined by IES (Illumination Engineering Society):

LED **module** + LED **driver** + **heatsink**



BB = **B**asic **B**oard, LED **module**

BEP = **B**asic **E**ngine **P**roduct, LED **Light Engine**

BEP40HR = **HR** engine = **always 9.25"** half round



BEP40 = Number (**40**) of **LEDs**

Determines Watts and lumens, **does NOT specify 9.25" PCB half round**

KEY information is the **two digits after the numbers**, example "**HR**"

BEP40HR-27 = **2700K CCT** (correlated color temperature in Kelvin, warm/cool), **-50** = **5000K**, etc.

BEP40HR-27-80 = **80 CRI** (color rendering index, 100 = the sun/incandescent), **-90** = **90 CRI**, etc.

PS12-350C-DIM-R = **P**ower **S**upply, **12** watts, **350**mA, Constant **C**urrent, **DIM**mable, **R**ound