

# Outdoor Lighting Planning Issues for Municipalities

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presented by  
West Chester Green Team  
Dark Skies Committee

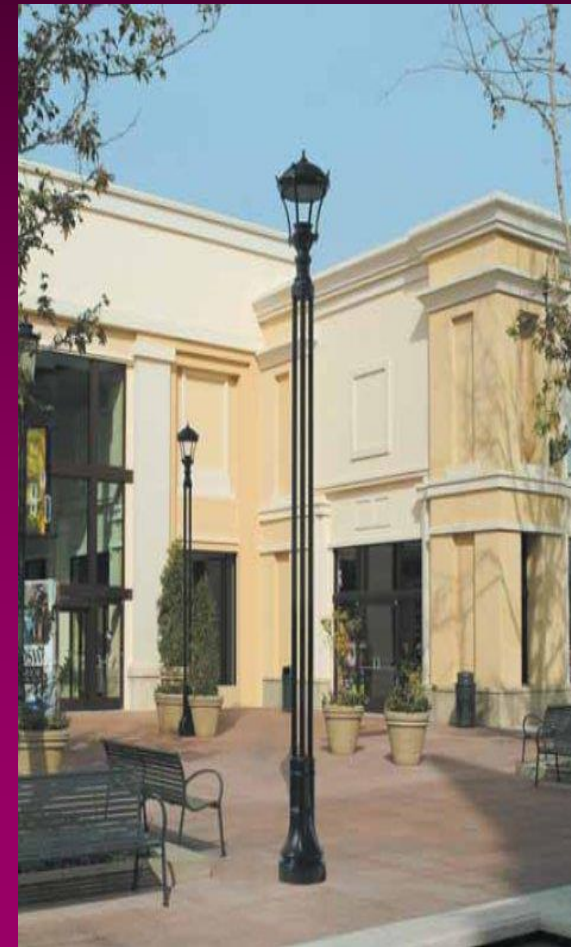
# Why is good outdoor lighting important?

- Good outdoor lighting is a community asset
- Enhances safety and sense of security
- Provides visibility for nighttime activities



# Why is good outdoor lighting important?

- Strengthens the themes and goals of the community while highlighting its amenities
- Communicates a positive visual image of the community, and visual order



# The Downside

Careless and excessive use of *light at night* can be detrimental:

- **Glare** – *too much light in our eyes – nuisance, discomfort, loss of visibility*
- **Light Trespass** – *light going where it isn't wanted*
- **Energy waste** – *uplight, light when or where it's not needed*
- **Adverse effects on human health** – *melatonin suppression, sleep disruption*
- **Adverse effects on nocturnal animals/plants** – *breeding and feeding disruption*
- **Urban skyglow** – *natural beauty of the night sky largely lost*

# The Downside (Cont'd)

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- Artificial light at night distorts environmental migratory cues
  - detrimental to bird migration
- Can decimate insect populations and interfere with age-old relationships between species
- Artificial Light at Night is an environmental pollutant that impacts biodiversity, human health, and cultural heritage



Tree dormancy  
disrupted by  
artificial light



# Glare

Good lighting aims and shields the source to prevent “glare.”

“Glare” is light that causes annoyance, discomfort or loss in visibility



# Glare





# Glare Under Control



# Light Trespass

Good lighting means placing the light only where it's needed or is *wanted*, to prevent *light trespass* and sky glow.



Courtesy RAB Lighting



Courtesy RAB Lighting

# Goals of Good Outdoor Lighting

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- Optimize *visibility* at night
- Minimize glare
- Minimize light trespass
- Minimize energy consumption
- Minimize negative impact on the environment
- Use the *right amount* of light, not too little and not too much

# Goals of Good Outdoor Lighting (Cont'd)

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- Lighting should create the set of conditions where our visual system can work efficiently.

(We see objects by reflected light and by contrast)



# Five Principles for Responsible Outdoor Lighting

Too often, outdoor electric lighting installations at night are over lit, left on when not needed, and are harmful to the environment. As a result, light pollution is a growing global issue that can negatively affect our environment and impact our quality of life. IDA and the Illuminating Engineering Society have published the joint Five Principles for Responsible Outdoor Lighting. By joining forces, our shared goal is to prevent and reduce light pollution through the proper application of quality outdoor electric lighting.

By applying these principles, properly designed electric lighting at night can be beautiful, healthy, and functional. Projects that incorporate these principles will save energy and money, reduce light pollution, and minimize wildlife disruption.

## LIGHT TO PROTECT THE NIGHT

### Five Principles for Responsible Outdoor Lighting



**Illuminating**  
ENGINEERING SOCIETY



#### USEFUL



#### ALL LIGHT SHOULD HAVE A CLEAR PURPOSE

Before installing or replacing a light, determine if light is needed. Consider how the use of light will impact the area, including wildlife and the environment. Consider using reflective paints or self-luminous markers for signs, curbs, and steps to reduce the need for permanently installed outdoor lighting.

#### TARGETED



#### LIGHT SHOULD BE DIRECTED ONLY TO WHERE NEEDED

Use shielding and careful aiming to target the direction of the light beam so that it points downward and does not spill beyond where it is needed.

#### LOW LIGHT LEVELS



#### LIGHT SHOULD BE NO BRIGHTER THAN NECESSARY

Use the lowest light level required. Be mindful of surface conditions as some surfaces may reflect more light into the night sky than intended.

#### CONTROLLED



#### LIGHT SHOULD BE USED ONLY WHEN IT IS USEFUL

Use controls such as timers or motion detectors to ensure that light is available when it is needed, dimmed when possible, and turned off when not needed.

#### COLOR



#### USE WARMER COLOR LIGHTS WHERE POSSIBLE

Limit the amount of shorter wavelength (blue-violet) light to the least amount needed.

# Today's Situation

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- Too much money and energy are wasted in providing bad outdoor lighting
- “Bad” lighting causes glare, light trespass and has too much or too little light for the outdoor seeing task
- Bad lighting diminishes the quality of life in the community
- Most people are unaware that much of our outdoor lighting fails to follow recognized good lighting practices



# How Did We Get Here?

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- Municipal codes have not kept pace with today's lighting technology, needs and practices
- Municipalities have comprehensive building codes, electrical codes, and energy codes, but too few have an *effective* outdoor lighting ordinance
- Electrical contractors have not gotten the word: their work is often characterized by the acronym GLUT = Glare, Light Trespass, Uplight, Too much light

# Impacts of Poor Outdoor Lighting Practices

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- Safety/Security
  - Glare and deep shadows *limit* visibility
- Social
  - Aesthetic Blight - Visual Clutter
  - Light trespass
  - Visual comfort is lacking

# Impacts of Poor Outdoor Lighting Practices (Cont'd)

- Economic
  - Billions of energy dollars wasted on *careless* and *excessive* use of outdoor lighting
  - An estimated \$6.4 billion *wasted annually* in the U.S.
  - Pennsylvania's share is about \$250 million *per yr*
    - Approx. 2.5 billion kilowatt-hours
    - Approx. 1.25 million *tons* if generated by coal (at 2000 kWh per ton)

# Impacts of Poor Outdoor Lighting Practices (Cont'd)

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- Environmental
  - Pollution from unnecessary electric power generation
  - Negative impact on nocturnal animals and migratory birds
  - Negative impact on plant life and pollinators
  - Exposure to light at night can adversely affect human health (melatonin suppression)

# Light Emitting Diodes

We're in an **LED** revolution...

Solid-state lighting has some advantages over conventional sources:

- Long life
- Energy efficiency
- Reduced maintenance
- No mercury
- Inherently directional
- Instant-on, dimmable
- Tunable spectrum
- Can be part of a digital infrastructure



# Light Emitting Diodes (Cont'd)

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## But:

- Prone to glare: still must be shielded
- Each emitter is like a *bare bulb*
- Light output diminishes over time
- Electronic driver can fail
- Still need to be cleaned
- May still need replacement
  - Lightning strikes
  - Traffic accidents
  - Storm damage



# LED Choices

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In addition to cost, safety and sustainability goals, LED sources are chosen based on qualities such as: *community acceptability, preference, other aspects of aesthetics, color fidelity, task performance, color discrimination, object detection via color contrast...*

Warm-appearing LEDs (2700K and 3000K) are preferred at night to limit blue light exposure.

# LED Spectral distributions

Our sky  
scatters blue  
light more

- Image credit:  
Flagstaff Dark Skies Coalition

See [HERE](#)

2200K

"warm-white" LED. This type of LED has not seen wide use.



LED  
2700K

Light-emitting diode with "correlated color temperature" (CCT) of 2700K – a "warm-white" LED.



LED  
3000K

Light-emitting diode with "correlated color temperature" (CCT) of 3000K – a "warm-white" LED.



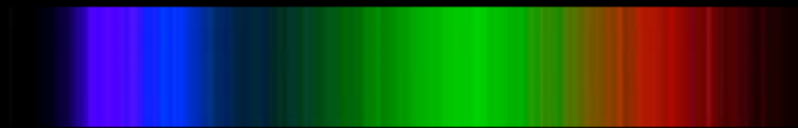
LED  
4100K

Light-emitting diode with CCT of 4100K – a "cool-white" LED. This is a common LED type in recent LED area lighting installations.



LED  
5100K

Light-emitting diode with CCT of 5100K – a "cool-white" LED. This also is a common LED type in recent LED area lighting installations.



# Resources

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- **Illuminating Engineering Society (IES)**
  - the recognized technical authority on illumination
  - communicate information on all aspects of good lighting practice
  - over 100 publications including recommended practices on a variety of applications, design guides, technical memoranda, and publications on energy management and lighting measurement
  - [www.ies.org](http://www.ies.org)

# Resources (Cont'd)

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## *Lighting Research Center*

at Rensselaer Polytechnic Institute, Troy, New York

<http://www.lrc.rpi.edu/>

World leading center for lighting research and education – pioneering research in solid-state lighting, light and health, transportation lighting, and energy efficiency

# Resources (cont'd)

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- International Dark-Sky Association (IDA)
- [www.darksky.org](http://www.darksky.org) Tucson, AZ
- Est. 1988, educational, environmental 501(c)(3) nonprofit dedicated to protecting and preserving the nighttime environment and our heritage of dark skies through quality outdoor lighting.
- With thousands of members in more than 70 countries, IDA is the leading authority concerning the problems and solutions related to *light pollution*.

### PENNSYLVANIA OUTDOOR LIGHTING COUNCIL



LIGHTING COUNCIL

- Search POLCouncil.org
- Municipal Section
- Initiating a Lighting Ordinance
- Sign & Billboard Lighting
- Find Your Local Ordinance
- Residential
- Outdoor Light Fixtures
- \$3.7 Billion A Year Wasted
- Common Lighting Terms
- PA Light Pollution Info
- POLC Meeting Dates
- What You Can Do
- Volunteer at POLC
- Donate to the POLC
- Email to POLC
- PowerPoint Presentations
- Light Pollution Brochures
- Outdoor Lighting Links
- First PA Dark Sky Park

## USE OUTDOOR LIGHTING WISELY

Visit POLC on **FaceBook**



Follow POLC on **Twitter**



Jan Romer



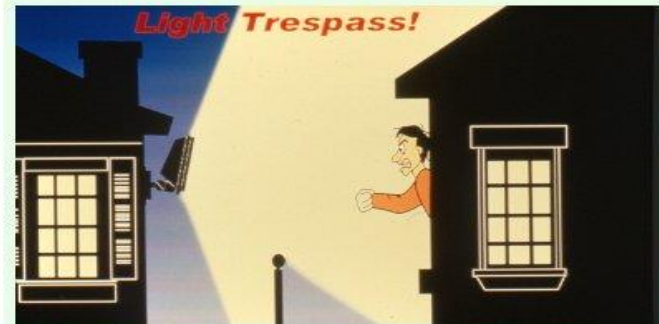
Fully Shielded parking lot lights

### Pennsylvania Outdoor Lighting Council

The Pennsylvania Outdoor Lighting Council, a not-for-profit group of volunteers founded in 1995, provides advice on solving the problems of glare, light trespass, energy waste, and skyglow caused by careless and excessive use of outdoor lighting. The goal of the POLC is to improve outdoor lighting practices in Pennsylvania by educating municipal officials and the public about good outdoor lighting. Good outdoor lighting provides the *right amount* of light, not too little and not too much, while minimizing glare, light trespass and energy consumption. Good outdoor lighting uses energy wisely and avoids the safety and nuisance problems of obtrusive lighting.

The Pennsylvania Outdoor Lighting Council's experienced advisers work free of cost directly with individuals, e.g., homeowners and businesses to solve outdoor lighting problems and with municipal governments to develop and enforce outdoor lighting ordinances that promote outdoor lighting quality for the comfort and safety of the municipality's residents and businesses. An important part of the POLC's work involves its [Model Outdoor Lighting Ordinances](#) which can be extremely useful particularly when a municipality lacks specific expertise with lighting issues, and seeks comprehensive and time-honored ordinance language that can be tailored to the municipality's specific needs.

Light Trespass is light going where it isn't wanted!



Courtesy RAB Lighting



Courtesy RAB Lighting



# Recommendations

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- Improve Outdoor Lighting Practices
  - Improves quality of life in our communities while *saving money*
  - Promotes energy efficiency
- Recognize *Waste Outdoor Lighting* as a significant environmental issue

# Recommendations (Cont'd)

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- Promote the use of:
  - *Intelligent light controls*, e.g. motion sensors, astronomic timers, programmable controllers
  - *Late night turn-off or dimming* of all lighting except as needed for safety/security
  - *Fully shielded light fixtures* to minimize glare light trespass, and wasted uplight

# Conclusion

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- Don't settle for bad lighting
- Educate the public about light at night
- An ordinance quantifies community expectations
- Enact an effective ordinance and enforce it

# Circadian Rhythm

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- Circadian means "approximately daily".
- In addition to the circadian clock in our brains, every organ and tissue so far studied contains its own circadian clock, all regulated by the master clock in the brain.
- The master clock in the brain is set by the daily light/dark cycle of sunlight that comes from living on a rotating earth.
- This cycle is present in all living things from plankton to primates.

# Light as a “Stimulus”

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- Light on the retina is a potent stimulus for regulating circadian, hormonal, and behavioral systems.
- In addition, light therapy is effective for certain affective disorders, sleep problems, and circadian rhythm disruption. In short, light acts like a drug.
- These biological and behavioral effects of light are influenced by distinct *non-visual photoreceptors in the eye*: melanopsin-containing *intrinsically photosensitive Retinal Ganglion Cells* (ipRGCs) in the retina, in addition to conventional rods and cones.