Unwinding the Myth of Scotopic Lumens

When should we use scotopic lumens to measure the effectiveness of a light source?

The answer, according David DiLaura, is "*Never!*"

DiLaura, a Fellow and Gold Medalist of the Illuminating Engineering Society writes in his article *Photopic and Scotopic Lumens – 4: When the Photopic Lumen Fails Us*,

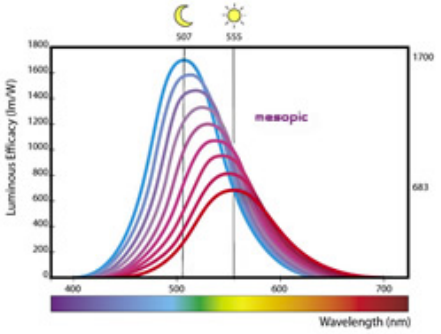
> *"There are no practical situations involving lighting or lighting design where occupants or users of a space are sufficiently dark adapted and using only their peripheral vision so that the scotopic luminous efficiency function would be a useful predictor of the visual effect of radiant power."*

Mr. DiLaura explains that relying on scotopic lumen output is impractical, because light that is brighter than a dim nightlight pushes our eyes out of the range of scotopic vision and into the ranges of mesopic or photopic vision.

Interaction With Light

Every interaction with light will always be situational, so when determining how to best light an area it is necessary to consider how people will interact with that light. Lighting professionals use three categories of vision to assist in that consideration:

- **Photopic vision**: relates to bright light intensity akin to daylight vision
- **Scotopic vision**: relates to near total darkness, relies on peripheral vision
- **Mesopic vision**: combines scotopic & photopic vision and makes up the range between the two



This might sound a little abstract, but if applied within a relatable scenario, scotopic, photopic, and mesopic vision are easy to understand.

The Practical Reality of Mesopic Vision

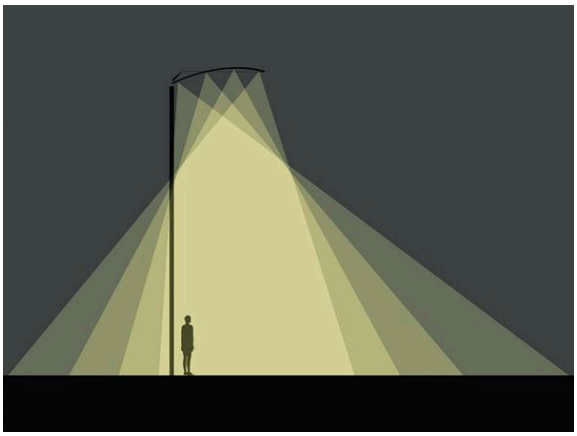
Imagine it is late at night. You are walking to your car that's parked in a garage some distance away and decide to take a short cut through a park to get there. The park has no lights, but you're familiar with the layout, so no problem. As you enter the park you are momentarily blind until your eyes adjust. Your reliance on peripheral vision, and the dim focus found in that periphery as you move, is an example of where scotopic vision is primarily used.

Making your way further through the park, the lights from the garage and street begin to shine through the dark foliage of the trees, and your eyes adjust again,

transitioning from scotopic vision to mesopic vision. As you continue into the light your vision progresses through the full mesopic range.

Finally, you leave the park and arrive at the garage. The lighting in the building is bright, and your eyes shift from using mesopic vision to photopic vision. Of course, some parking garages or streets might have shadowy areas that the overhead lamps don't quite illuminate. Walking through these areas again force the eye to dilate, adjusting back and forth between photopic and mesopic modes.

This scenario illustrates that, aside from walking in pitch-dark parks, lying in your bedroom trying to sleep, and the like, humans spend the vast majority of our days and nights between mesopic and photopic light levels.



> *"If there is a light on near you it's a good bet you are in the photopic or mesopic vision range.*

So when calculating how a light system performs, and the best application for that system, why would we ever use a scotopic factor when it is at the extreme bottom of the spectrum?

This postulation calls to question one of the largest marketing campaigns the world has ever seen: the LED industry's promotion of the scotopic factor as a primary criterion for quantifying lumen output.

The Scotopic Fallacy Revealed

Many LED marketing strategies directly advocate the importance of scotopic lumen efficiency, often using alternate, less-technical words such as pupil lumens or visually effective lumens, even though such factors have little value when designing lighting retrofits and installations.

When light application and design is considered with the intention of practical, human interaction it becomes obvious that basing light efficacy off of scotopic lumen outputs is not only impractical, but can be quite misleading.

Why promote it then?

A common position taken by LED advocates relies on research demonstrating that scotopic vision helps determine pupil dilation, which affects the way our eyes focus.

But, recalling DiLaura's observation, he makes it clear there aren't any practical instances in which scotopic factors to be an effective predictor of a system's light radiance. So, why do LED companies so persistently promote scotopic luminous efficiency?

Because their products fail to compete using more relevant criteria.

The industry is being coerced into inappropriately adopting scotopic lumen factors as a standard used to mask the shortcomings of LED and Induction lighting.

A Light at the End of the Tunnel

We at Global Energy & Lighting believe the use of the scotopic lumen factor *must* be reconsidered.

The truth is, scotopic vision is used to see in the dark. If there is a light on near you it's a good bet you are in the photopic or mesopic vision range. The simple act of installing lighting eliminates the relevance of scotopic data.

Research done at the Rensselaer Polytechnic Institute's Lighting Research Center (LRC) has solved the problem of scotopic lumen reliance by developing a "Unified System of Photometry." This system can measure any light level – including mesopic.

LED marketing campaigns work hard promoting the critical value of scotopic lumen measurements, refusing to acknowledge the superiority of the mesopic data – even in the face of the recent developments and research from Rensselaer Polytechnic Institute's LRC.

We at Global Energy & Lighting believe in using the most applicable and relevant measurement of lumen output to measure our systems. We insist that our lighting measurements to be based off of what is best for our clients and customers, not just what makes our product look good.