



U.S. Department of Energy  
Energy Efficiency and Renewable Energy

# Hitting the Target: ENERGY STAR SSL Outdoor Lighting Criteria

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Pacific Northwest National Laboratory

DOE Webcast  
October 8, 2009



## Presentation Overview

- New applications for ENERGY STAR SSL Category A
  - Why add these applications?
  - 07/01/09 draft criteria
    - ❖ Comments received
    - ❖ Responses to comments
  - Proposed revisions to draft criteria



## New Outdoor Applications for Category A

- Pole-mounted area and roadway luminaires
  - Includes decorative and historic
  - *Excludes bollards (already covered in Version 1.1)*
- Wall-mounted area luminaires (“wall packs”)
  - *Excludes steplights*
- Ceiling-mounted garage and canopy luminaires





## Why Add These Applications?

- Very active area of the SSL market
- High level of interest from energy-efficiency programs, municipalities, and other stakeholders
- CALiPER testing has revealed a wide range of performance
- Demonstration projects indicate potential for large energy savings *and* the need for performance guidelines



## Ceiling-Mounted 07/01/09 Draft Criteria

<b>Metric</b>	<b>Requirement</b>
Minimum Light Output	Luminaire shall deliver a minimum of 2,000 lumens (initial).
Zonal Lumen Density Requirement	Luminaire shall deliver a minimum of 20% of total lumens in the 60°- 70° zone.
Minimum Luminaire Efficacy	70 lm/W



## Ceiling-Mounted 07/01/09 Draft Criteria

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Minimum Light Output	Luminaire shall deliver a minimum of 2,000 lumens (initial).
Zonal Lumen Density Requirement	Luminaire shall deliver a minimum of 20% of total lumens in the 60°- 70° zone.
Minimum Luminaire Efficacy	70 lm/W

- Comment
  - The minimum efficacy requirement is too stringent.
- Response
  - 70 lm/W is needed to produce energy savings over the predominant incumbent technologies, i.e. fluorescent and HID.



## Ceiling-Mounted [Proposed Criteria Revision](#)

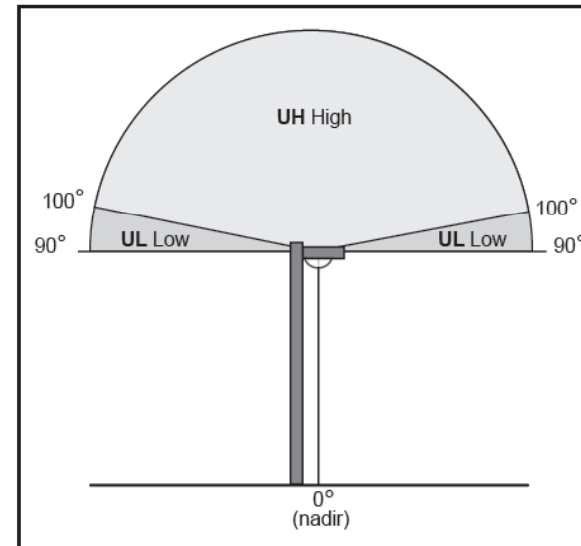
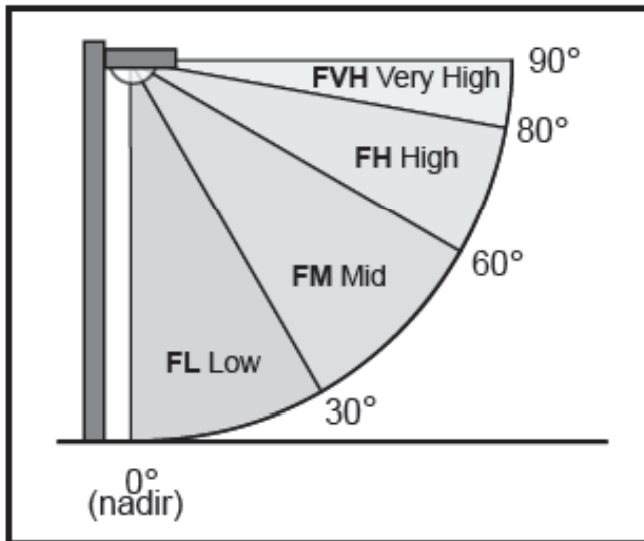
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Minimum Luminaire Efficacy	70 lm/W

- No proposed changes



## Wall-Mounted 07/01/09 Draft Criteria

Metric	Requirement	
Minimum Light Output	Luminaire shall deliver a minimum of 300 lumens (initial).	
Maximum Luminous Flux in Glare and Uplight Zones	FH (60-80°)	48.0% of total luminaire output
	FVH (80-90°)	3.0% of total luminaire output
	UL (90-100°)	2.0% of total luminaire output
	UH (100-180°)	2.0% of total luminaire output
Minimum Luminaire Efficacy	52 lm/W	





## Wall-Mounted Proposed Criteria Revision

Metric	Requirement	
Minimum Light Output	Luminaire shall deliver a minimum of 300 lumens (initial).	
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	FVH (80-90°)	3.0% of total luminaire output
	UL+UH (90-180°)	Zero light at or above horizontal
Minimum Luminaire Efficacy	52 lm/W	

- Comment
  - Upward-directed light is wasted and contributes to urban sky glow.
- Response
  - The intent of the previous draft was to align as closely with IES as possible. **The uplight allowances will be eliminated.**



## Pole-Mounted 07/01/09 Draft Criteria

Minimum Light Output		Luminaire shall deliver a minimum of 1,000 lumens (initial).			
Minimum Fitted Target Efficacy, or FTE (lm/W)		Shielded ( $< 1.5$ MH house-side)		Unshielded ( $\geq 1.5$ MH house-side)	
		Low Output $< 9,500$ lumens	High Output $\geq 9,500$ lumens	Low Output $< 13,300$ lumens	High Output $\geq 13,300$ lumens
		37	48	53	70
Maximum Luminous Flux in Glare and Uplight Zones	FH (60-80°)	48.0% and 12,000 lumens			
	BH (60-80°)	20.0% and 5,000 lumens		48.0% and 12,000 lumens	
	FVH (80-90°)	3.0% and 750 lumens			
	BVH (80-90°)	3.0% and 750 lumens			
	UL (90-100°)	4.0% and 1,000 lumens			
	UH (100-180°)	4.0% and 1,000 lumens			



## Pole-Mounted 07/01/09 Draft Criteria

Minimum Light Output	Luminaire shall deliver a minimum of 1,000 lumens (initial).
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- Comment
  - What was the basis for the minimum output value?
- Response
  - 35W HPS lamp in a shielded luminaire having 50% optical efficiency.



## Pole-Mounted 07/01/09 Draft Criteria

Maximum Luminous Flux in Glare and Uplight Zones	FH (60-80°)	48.0% and 12,000 lumens	
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	FVH (80-90°)	3.0% and 750 lumens	
	BVH (80-90°)	3.0% and 750 lumens	
	UL (90-100°)	4.0% and 1,000 lumens	
	UH (100-180°)	4.0% and 1,000 lumens	

- Comment
  - Why wasn't the BUG system incorporated in its entirety? Lighting Zones are not addressed.
- Response
  - Lighting Zones (and BUG ratings) cannot be addressed independent of the specific project.



## Pole-Mounted 07/01/09 Draft Criteria

Maximum Luminous Flux in Glare and Uplight Zones	UL (90-100°)	4.0% and 1,000 lumens
	UH (100-180°)	4.0% and 1,000 lumens

- Comment
  - The uplight restrictions are too lenient. Upward-directed light is wasted and contributes to urban sky glow.
- Response
  - The intent in the previous draft was to align as closely with IES as possible. **The uplight allowances will be eliminated.**



## Pole-Mounted 07/01/09 Draft Criteria

Maximum Luminous Flux in Glare and Uplight Zones	FH (60-80°)	48.0% and 12,000 lumens	
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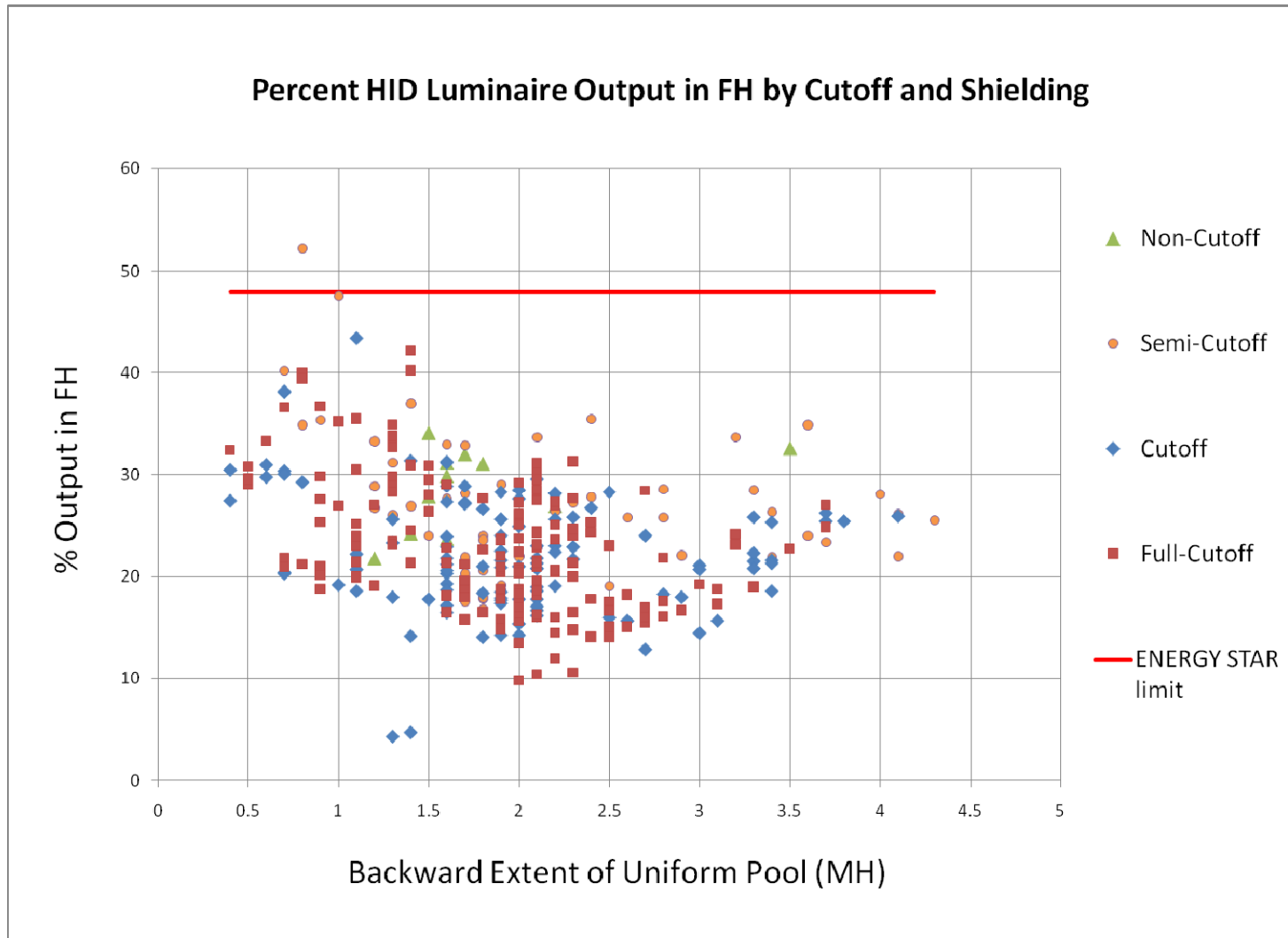
### ■ Comment

- Restrictions on FH, BH, FVH, and BVH lumens will discourage the use of high-performance luminaires.

### ■ Response

- Restrictions on high-angle brightness don't affect LPD if wattage and spacing/MH are optimal. FVH and BVH were correlated to the old IES "cutoff" system. FH and BH were then scaled per BUG.

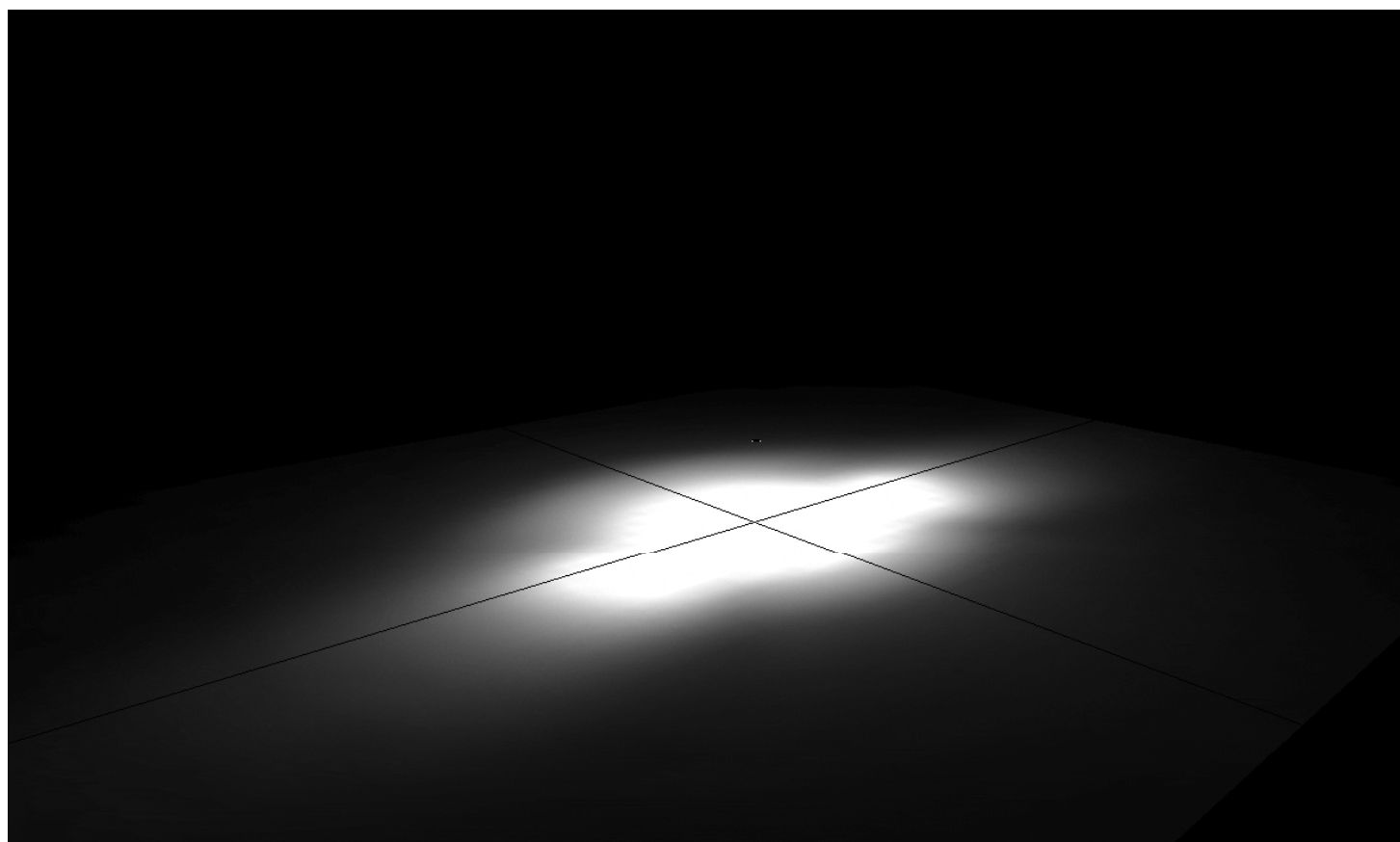






## Pole-Mounted 07/01/09 Draft Criteria: FTE

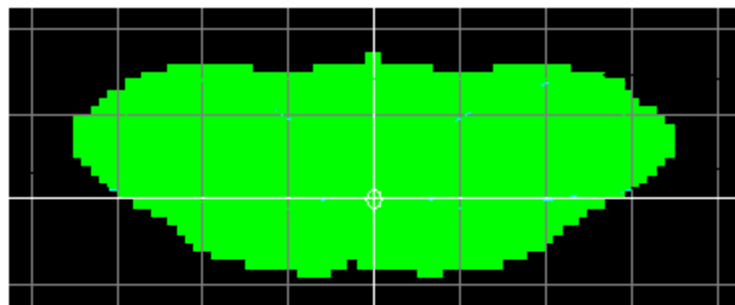
- New Project-Independent Metric





## Pole-Mounted 07/01/09 Draft Criteria: FTE

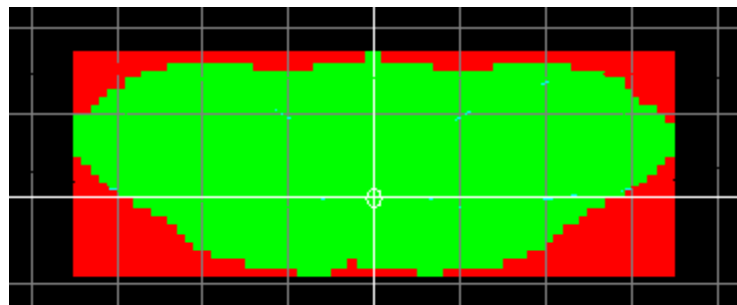
- New Project-Independent Metric
  1. Determines the **Uniform Pool** of illumination unique to each luminaire and sums the luminous flux landing therein





## Pole-Mounted 07/01/09 Draft Criteria: FTE

- New Project-Independent Metric
  1. Determines the Uniform Pool of illumination unique to each luminaire and sums the luminous flux landing therein
  2. Fits a **Rectangular Target** to surround the **Uniform Pool** and finds the % of **Rectangular Target** covered by the **Uniform Pool**





## Pole-Mounted 07/01/09 Draft Criteria: FTE

- **New Project-Independent Metric**
  1. Determines the Uniform Pool of illumination unique to each luminaire and sums the luminous flux landing therein
  2. Fits a Rectangular Target to surround the Uniform Pool and finds the % of Rectangular Target covered by the Uniform Pool
  3. The summed lumens are scaled (down) by the % coverage and then divided by input wattage (lm/W)



## Pole-Mounted 07/01/09 Draft Criteria: FTE

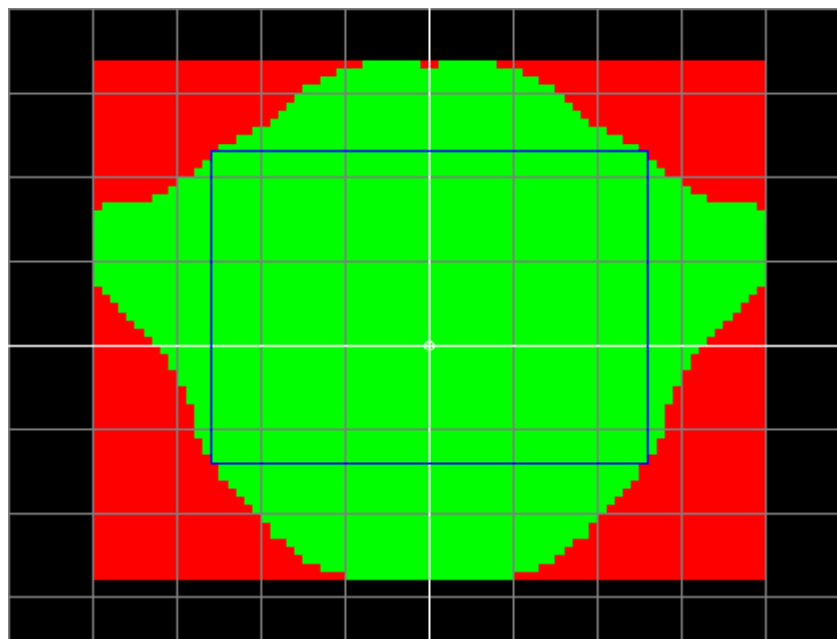
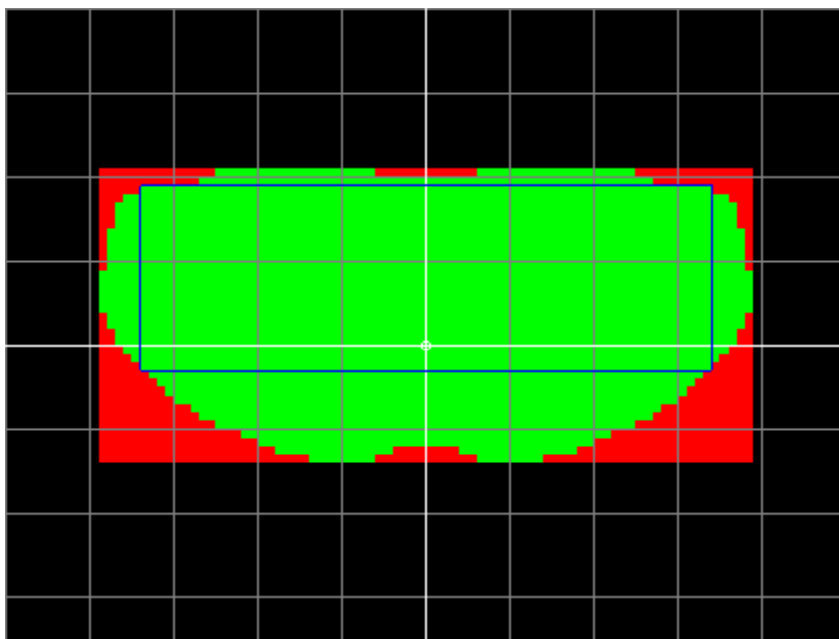
### ■ Primary benefits:

✓	Application Independent
✓	Evaluation of Efficacy (lm/W)
✓	Effectiveness of HS Shielding
✓	Utility of Distribution Shape
✓	No Arbitrary Proportions

- Flexibility for designers and manufacturers
- Effective HS shielding is rewarded, *not required*
- Area of coverage is described, *not prescribed*
- Apples-to-apples comparison *for similar distributions*, independent of MH, illuminance, etc.



## Pole-Mounted 07/01/09 Draft Criteria



Type II Short  $\neq$  Type II Short



## Pole-Mounted 07/01/09 Draft Criteria: FTE

- Product Evaluation
  1. Import IES-format *absolute*-photometry data file into *software already developed* by DOE

[http://www1.eere.energy.gov/buildings/ssl/criteria\\_development.html](http://www1.eere.energy.gov/buildings/ssl/criteria_development.html)

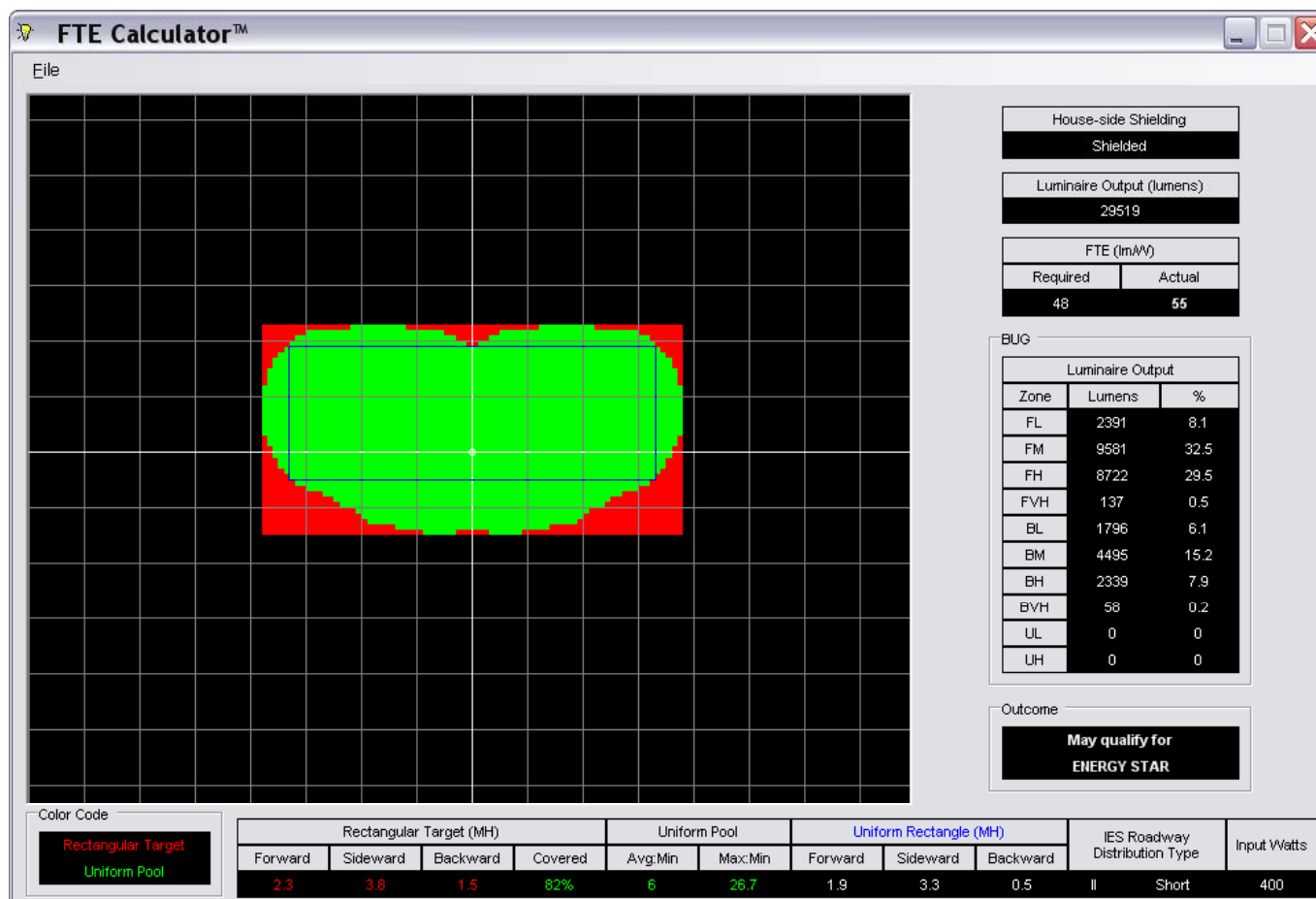


## Pole-Mounted 07/01/09 Draft Criteria: FTE

- Product Evaluation
  1. Import IES-format *absolute*-photometry data file into *software already developed* by DOE
  2. Review software output



## Pole-Mounted 07/01/09 Draft Criteria: FTE





## Pole-Mounted 07/01/09 Draft Criteria

Minimum Fitted Target Efficacy, or FTE (lm/W)	Shielded ( $< 1.5$ MH house-side)		Unshielded ( $\geq 1.5$ MH house-side)	
	Low Output $< 9,500$ lumens	High Output $\geq 9,500$ lumens	Low Output $< 13,300$ lumens	High Output $\geq 13,300$ lumens
	37	48	53	70

- Comment
  - Consider site-specific requirements when establishing criteria, e.g. required illuminance, roadway width, lighting power density (LPD), etc.
- Response
  - Site-specific criteria cannot be addressed at the luminaire-qualification level. Appropriate luminaires should be selected by qualified designers.



## Pole-Mounted 07/01/09 Draft Criteria

Minimum Fitted Target Efficacy, or FTE (lm/W)	Shielded (< 1.5 MH house-side)		Unshielded (≥ 1.5 MH house-side)	
	Low Output < 9,500 lumens	High Output ≥ 9,500 lumens	Low Output < 13,300 lumens	High Output ≥ 13,300 lumens
	37	48	53	70

- Comment

- It would be overly selective to expect LED to outperform 75<sup>th</sup> percentile HID by 20%.

- Response

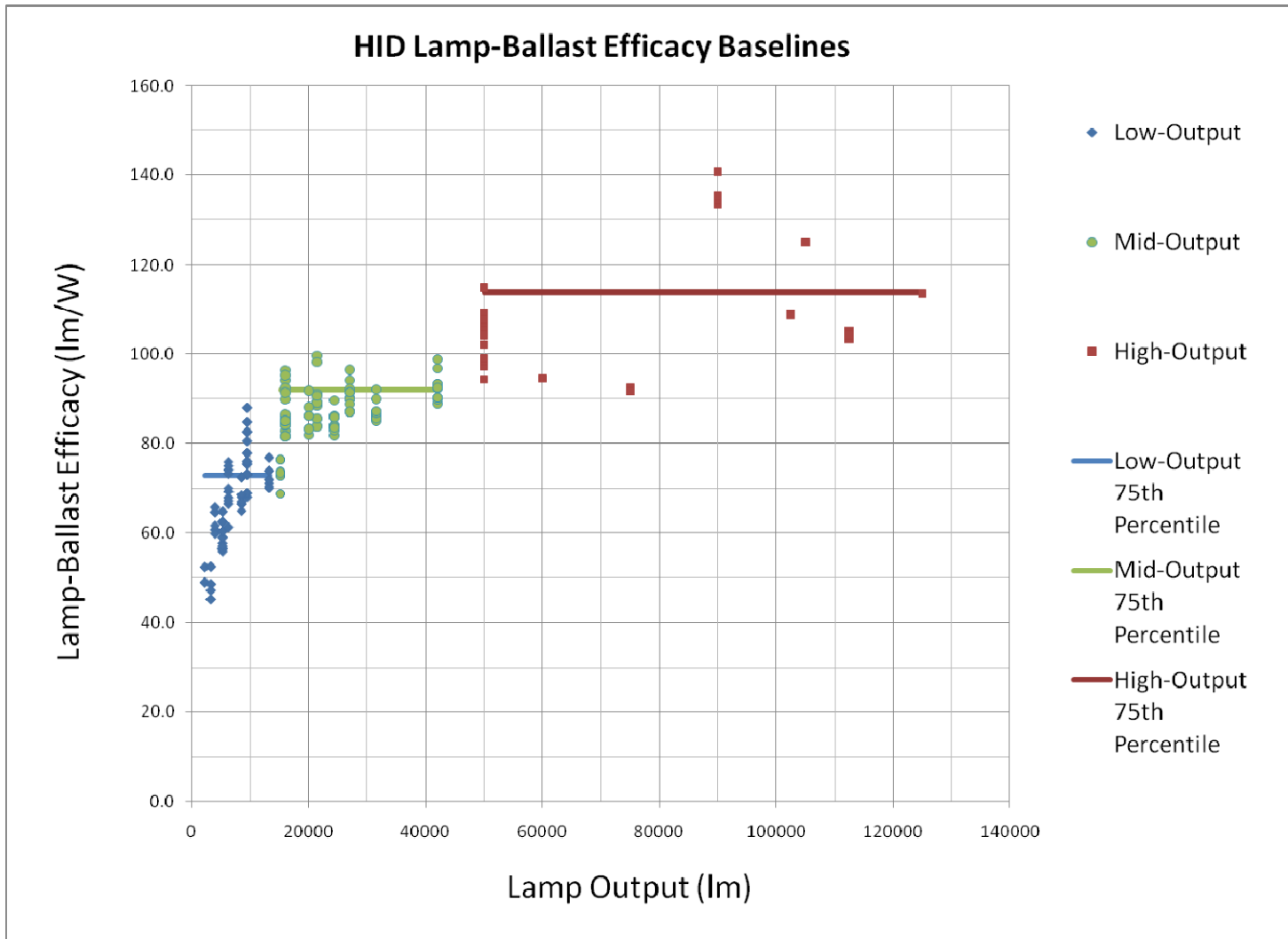
- Requirements will be reduced to 75<sup>th</sup> percentile HID performance. Additionally, a Mid-Output category will be created.

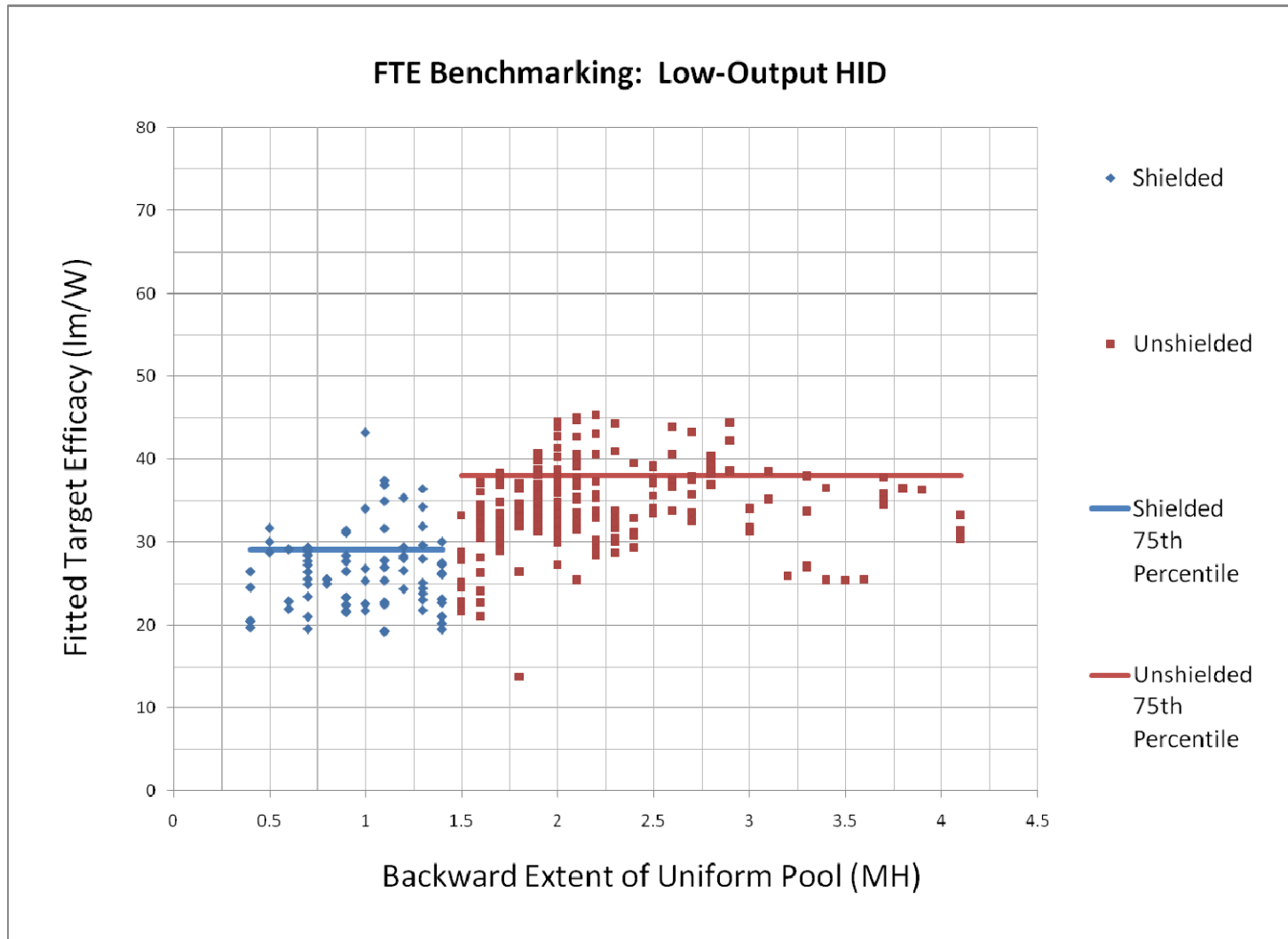


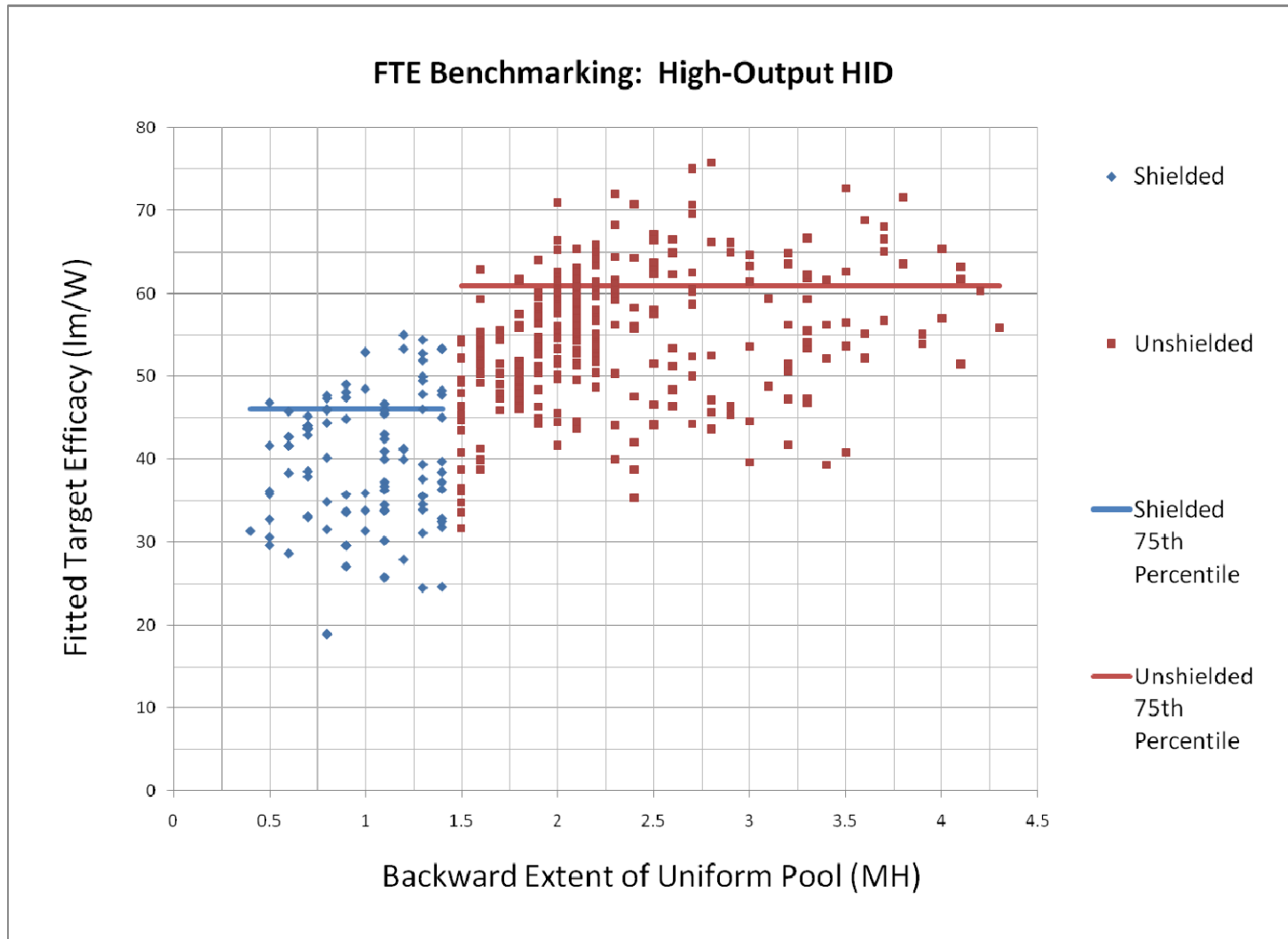
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	Low Output < 9,500 lumens	High Output ≥ 9,500 lumens	Low Output < 13,300 lumens	High Output ≥ 13,300 lumens
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- Comment
  - Provide summary statistics for benchmarking data.
- Response
  - 75<sup>th</sup> percentile HID lamp/ballast efficacies:
    - ❖ Low – 73 lm/W
    - ❖ Mid = 92 lm/W
    - ❖ High = 114 lm/W









## Pole-Mounted 07/01/09 Draft Criteria

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	37	48	53	70

- Comment
  - Dimmable products may not meet requirements in one or more operating modes.
- Response
  - **A note will be added** to the criteria clarifying that luminaires will be tested in their full-output mode.



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Minimum Fitted Target Efficacy, or FTE (lm/W)	Shielded ( $< 1.5$ MH house-side)		Unshielded ( $\geq 1.5$ MH house-side)	
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- Comment
  - Some distributions are designed for lateral asymmetry, and these would be unfairly penalized.
- Response
  - **The algorithm will be revised/simplified** to eliminate the requirement for symmetry. Note that FTE is **not** intended to evaluate luminaires designed for Small Target Visibility (STV).



## Pole-Mounted 07/01/09 Draft Criteria

Minimum Fitted Target Efficacy, or FTE (lm/W)	Shielded (< 1.5 MH house-side)		Unshielded (≥ 1.5 MH house-side)	
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	37	48	53	70

- Comment
  - The uniformity criteria are arbitrary, won't apply to every application, and will discard useful flux.
- Response
  - 6:1 avg:min is the most lenient criterion in IES RP-8 and correlates to 30:1 max:min for Uniform Pools produced by HID luminaires.



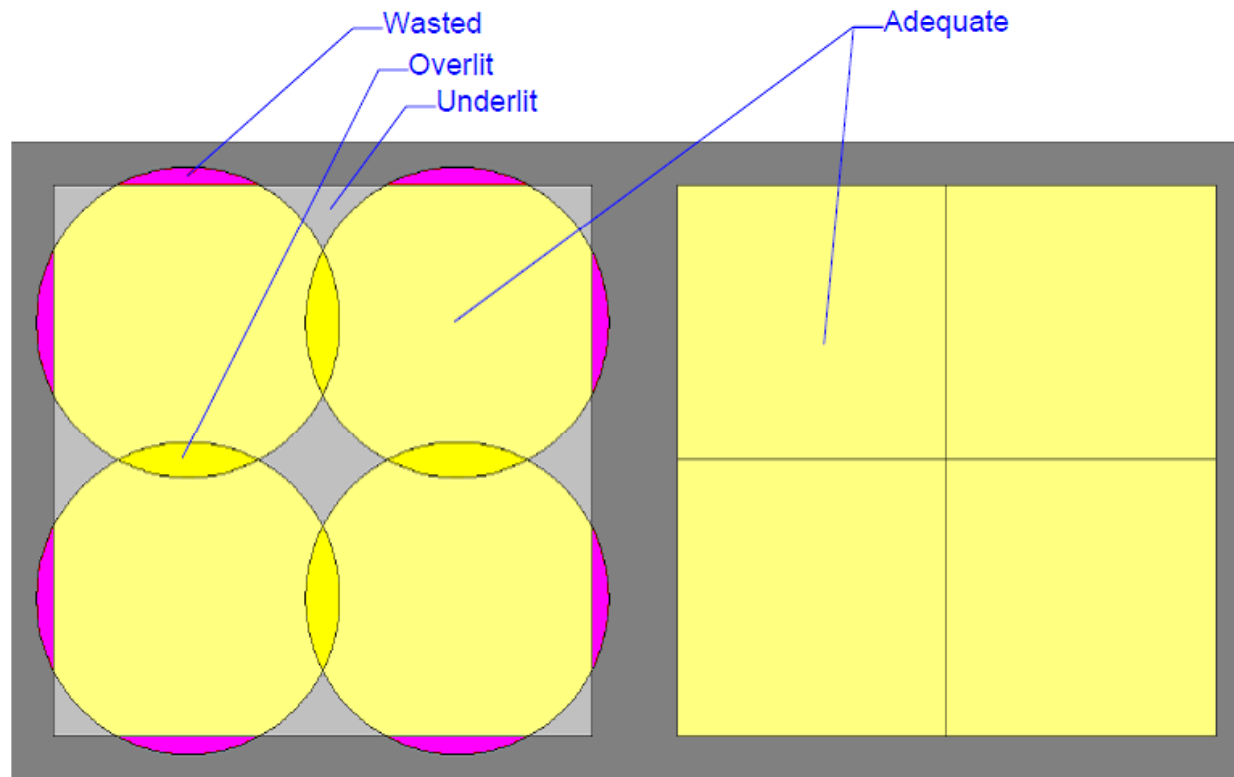
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- Comment
  - Not all tasks are rectangular.
- Response
  - Most tasks (roads or parking lots) cannot be lit by a single pole. Large areas are most efficiently illuminated by an evenly spaced grid of poles, and the areas between poles are most efficiently covered by rectangular patterns.



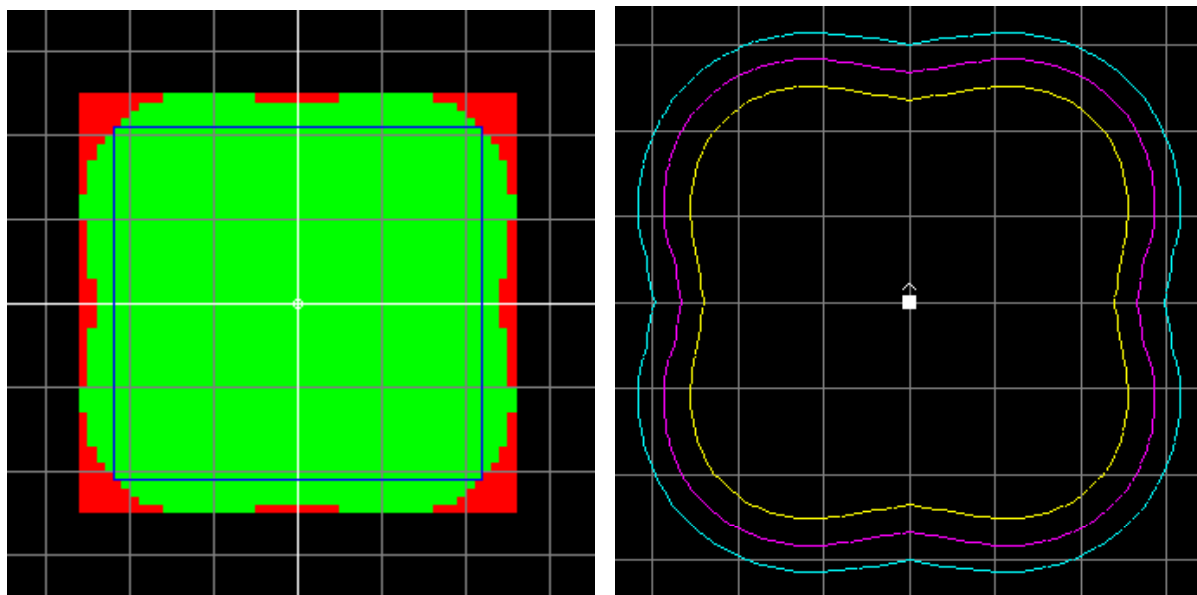
## Pole-Mounted 07/01/09 Draft Criteria



*Simplified* comparison of distributions of equal area



## Pole-Mounted 07/01/09 Draft Criteria



Perfect right-angle corners aren't necessary



## Pole-Mounted 07/01/09 Draft Criteria

Minimum Fitted Target Efficacy, or FTE (lm/W)	Shielded ( $< 1.5$ MH house-side)		Unshielded ( $\geq 1.5$ MH house-side)	
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- Comment
  - The metric should favor larger areas of coverage.
- Response
  - A large area of coverage can reduce initial system cost and embodied energy, but ongoing energy consumption (the bulk of life-cycle impact) remains the primary concern of ENERGY STAR.



## Pole-Mounted 07/01/09 Draft Criteria

Minimum Fitted Target Efficacy, or FTE (lm/W)	Shielded ( $< 1.5$ MH house-side)		Unshielded ( $\geq 1.5$ MH house-side)	
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- Comment
  - High-Output and Unshielded luminaires are unfairly discouraged.
- Response
  - HID (baseline) efficacy improves with increased output and reduced shielding, so more stringent FTE requirements are appropriate for these categories.



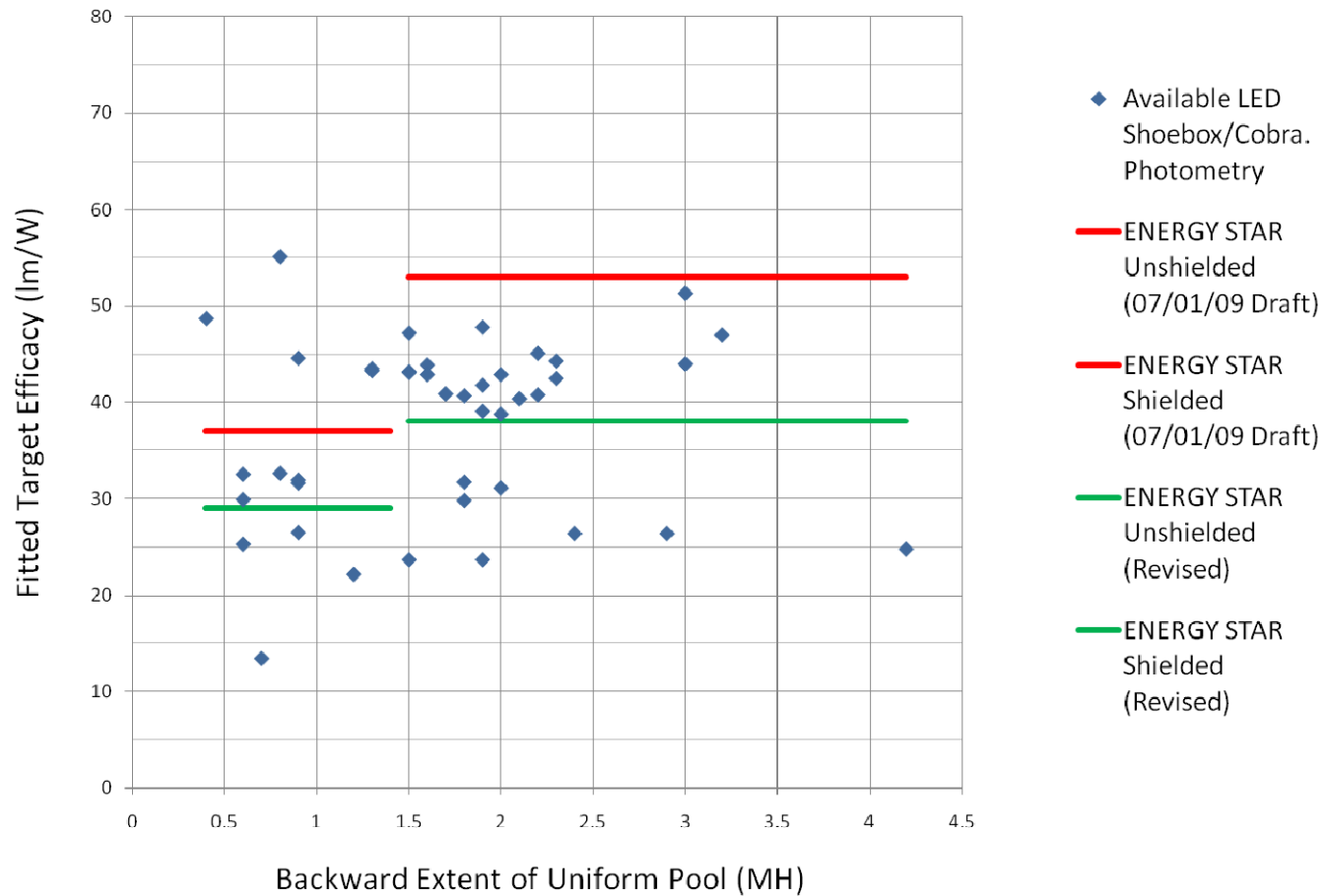
## Pole-Mounted Proposed Criteria Revision

Minimum Light Output		Luminaire shall deliver a minimum of 1,000 lumens (initial).					
Minimum Fitted Target Efficacy, or FTE (lm/W)		Shielded ( $< 1.5$ MH house-side)			Unshielded ( $\geq 1.5$ MH house-side)		
		Low-Output $< 7,500$ lm	Mid-Output	High-Output $> 23,500$ lm	Low-Output $< 10,500$ lm	Mid-Output	High-Output $> 33,000$ lm
		29	37	46	38	49	61
Maximum Luminous Flux in Glare and Uplight Zones	FH (60-80°)	48.0% and 12,000 lumens					
	BH (60-80°)	20.0% and 5,000 lumens			48.0% and 12,000 lumens		
	FVH (80-90°)	3.0% and 750 lumens					
	BVH (80-90°)	3.0% and 750 lumens					
	UL+UH (90-180°)	Zero light at or above horizontal					

- Baseline set at 75<sup>th</sup> percentile HID performance
  - No longer 20% savings over 75<sup>th</sup> percentile

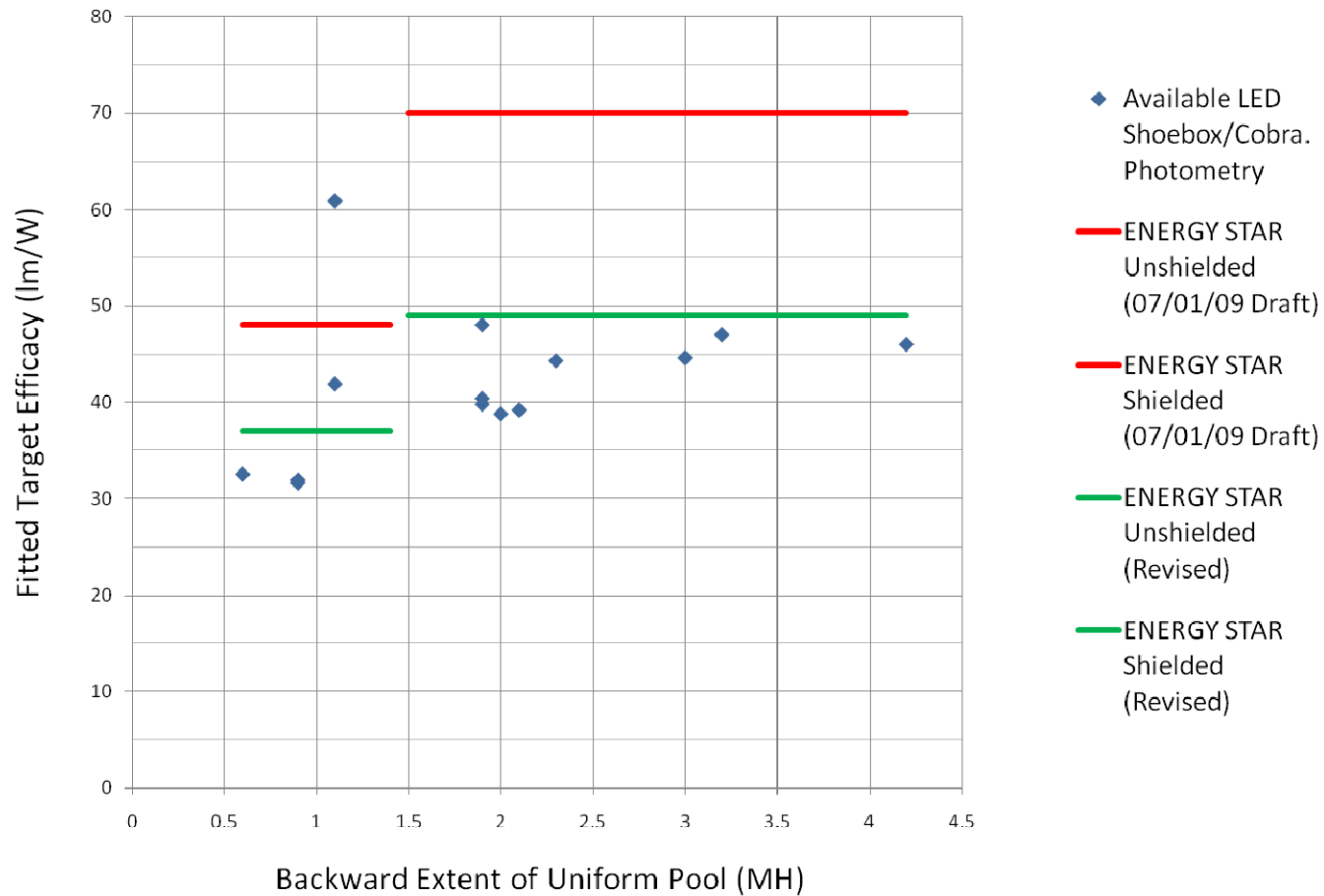


### Potential Impact of Revised FTE Baselines on ENERGY STAR Qualification of Low-Output LED Luminaires





### Potential Impact of Revised FTE Baselines on ENERGY STAR Qualification of Mid-Output LED Luminaires





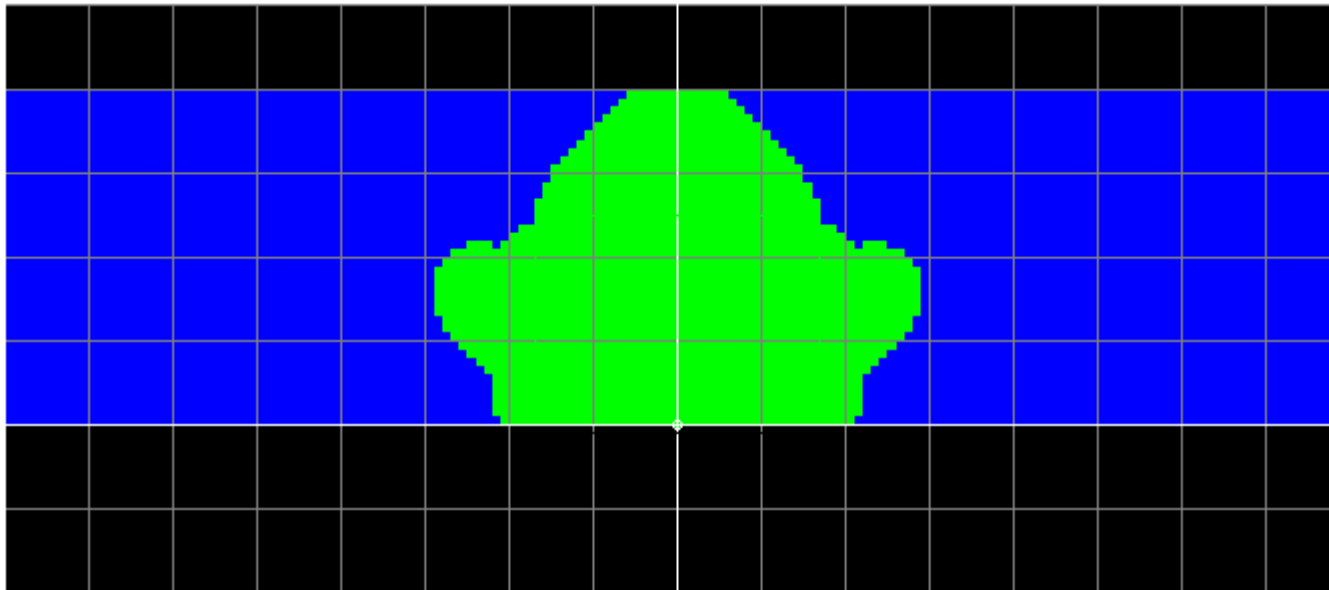
## Pole-Mounted 07/01/09 Draft Criteria

- Comment
  - Did you consider using Target Efficacy Rating (TER) as defined in NEMA LE 6-2008?
- Response
  - TER was evaluated but not adopted because neither uniformity nor shape of distribution are evaluated, and due to improper treatment of backlight.
  - A possible revision, to include backlight to 1.0-MH for Types **II-III-IV**, would be a major improvement.
    - ❖ Vote scheduled for 10/07/09 (yesterday).



## Pole-Mounted 07/01/09 Draft Criteria

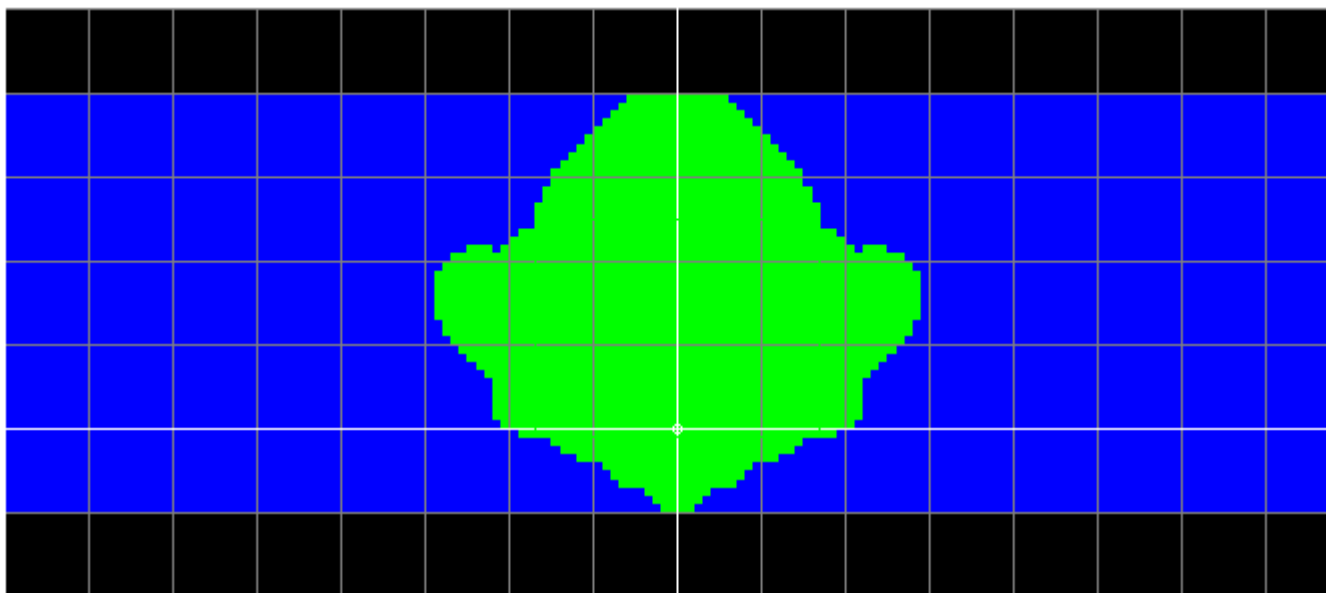
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## Pole-Mounted 07/01/09 Draft Criteria

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- Response





U.S. Department of Energy  
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