ENERGY STAR® SSL
Keeping Pace with Technology

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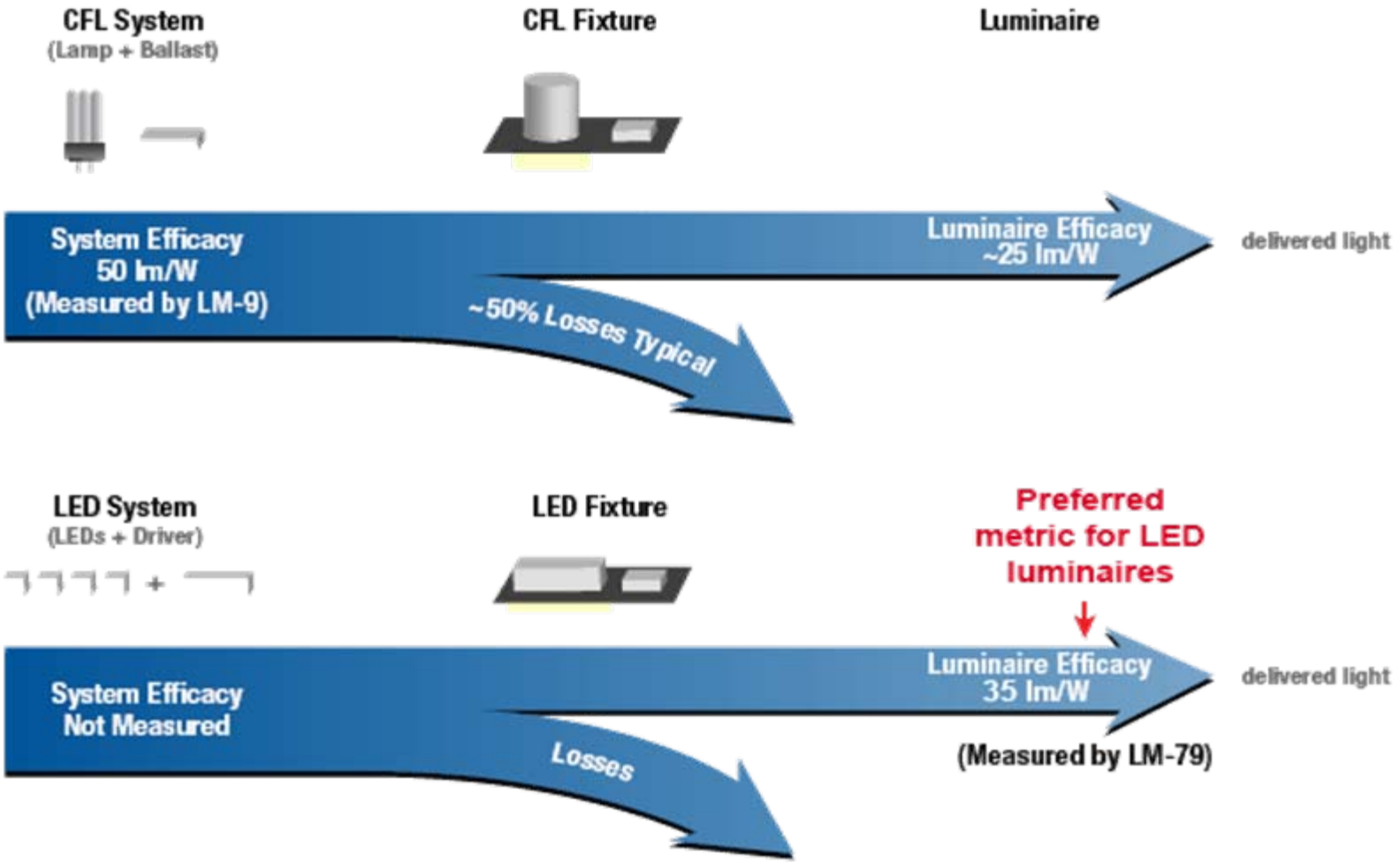
System Efficacy Vs. Luminaire Efficacy

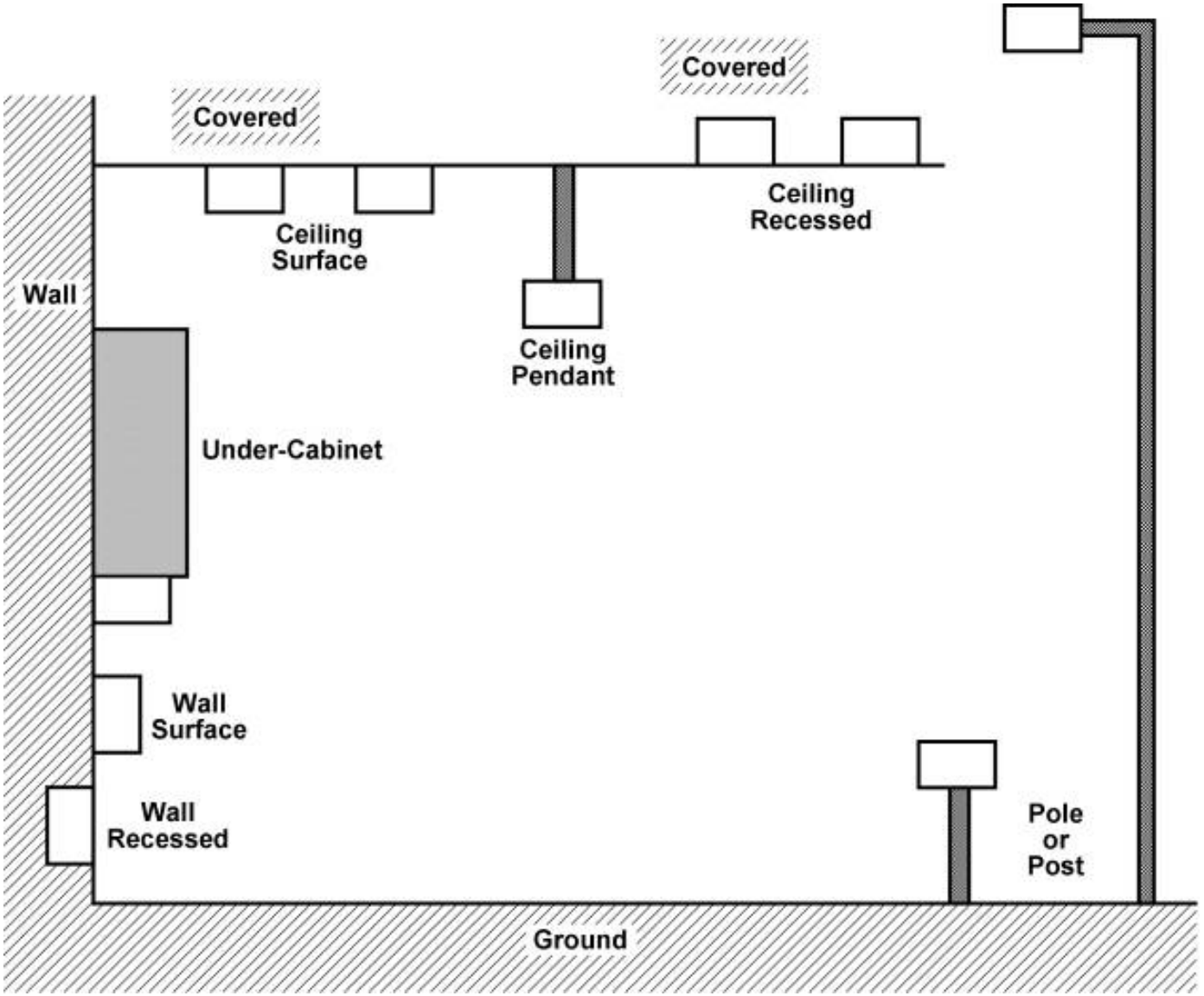
(Recessed Downlights Example)



In Situ Testing Requirement

- Life (lumen depreciation) determined by in situ temperature measurements of:
  - Module, Array or “Light Engine”
  - Power Supply/Driver
- Testing may be conducted at the same time as UL 1598.

UL 1598 Environments



Temperature Measurement Point (TMP)

- Manufacturer designated TMP correlating to LM-80 test report or power supply warranty
  - Module/Array
    - Solder Joint Temperature T_s
    - Case Temperature T_c
    - Board Temperature T_b
  - Power Supply
    - Case Temperature T_c
    - Could also be T_b for integral Power Supplies

Lumen Depreciation "Passing" Criteria

A luminaire passes the L_{70} threshold (≥ 25,000 hours for indoor residential and ≥ 35,000 for all others) …

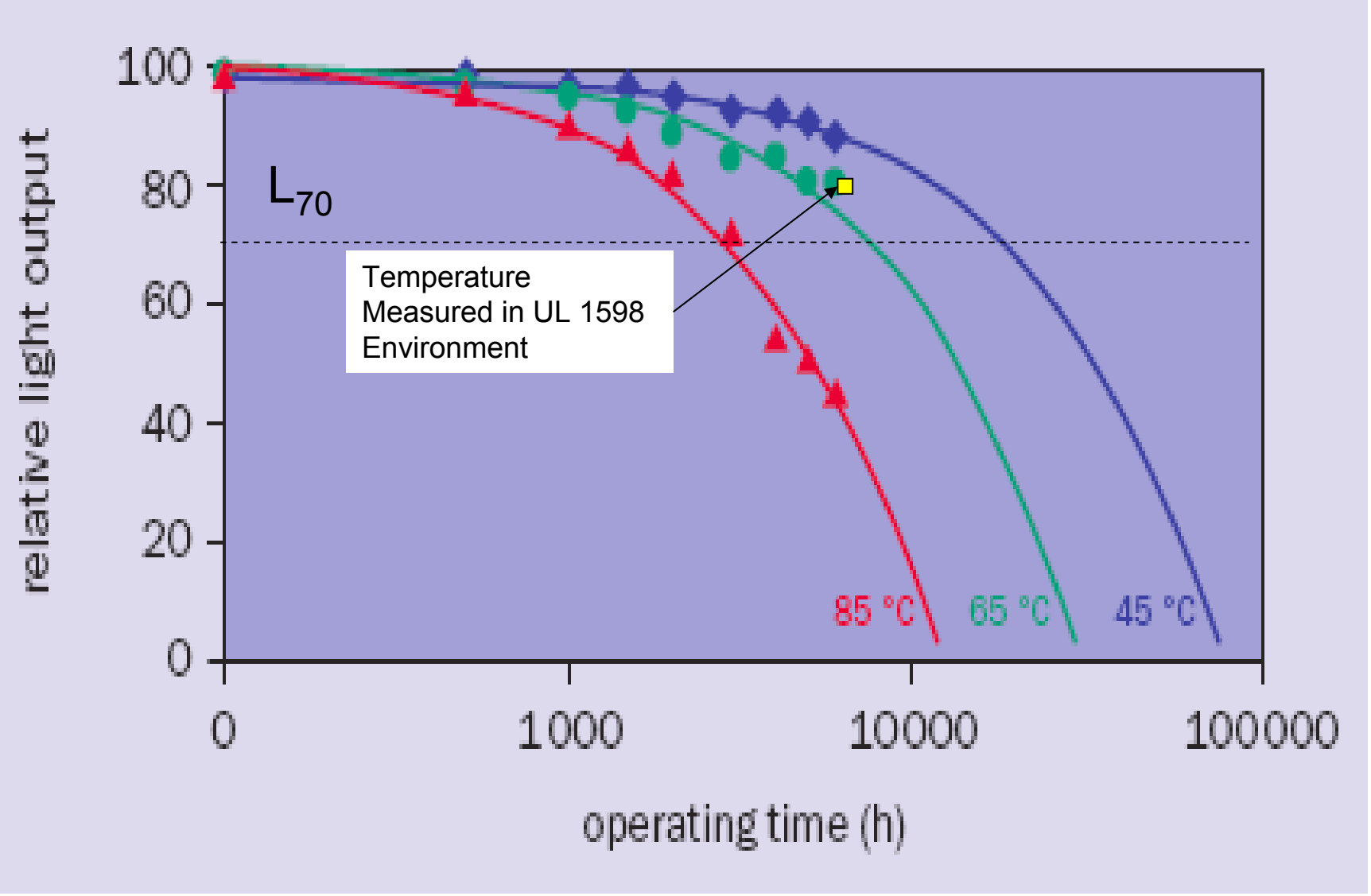
- if the in situ measured drive current is the same or lower

AND

- if the in situ measured TMP for the device/module/array is the same or lower

… than the LM-80 test report provided for the device/module/array.

Sample LM-80 Test Report



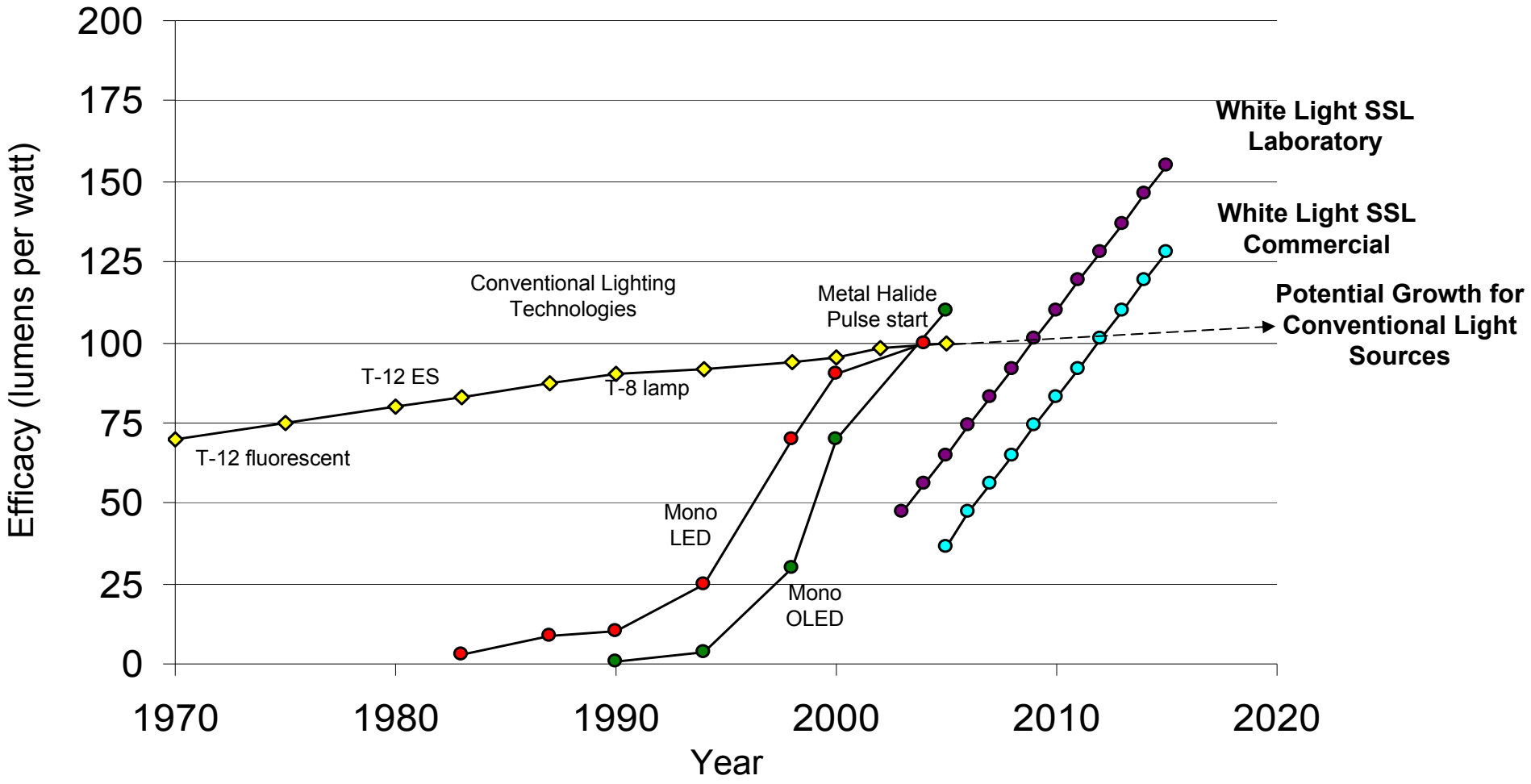
Transitional Two-Category Approach

- Approach recognizes rapidly changing technology
- Allows early participation of limited range of SSL products for directional lighting applications (Category A)
- At some point (~3 years), Category A will be dropped entirely; Category B then becomes basis of criteria

Rapidly Changing SSL Technologies

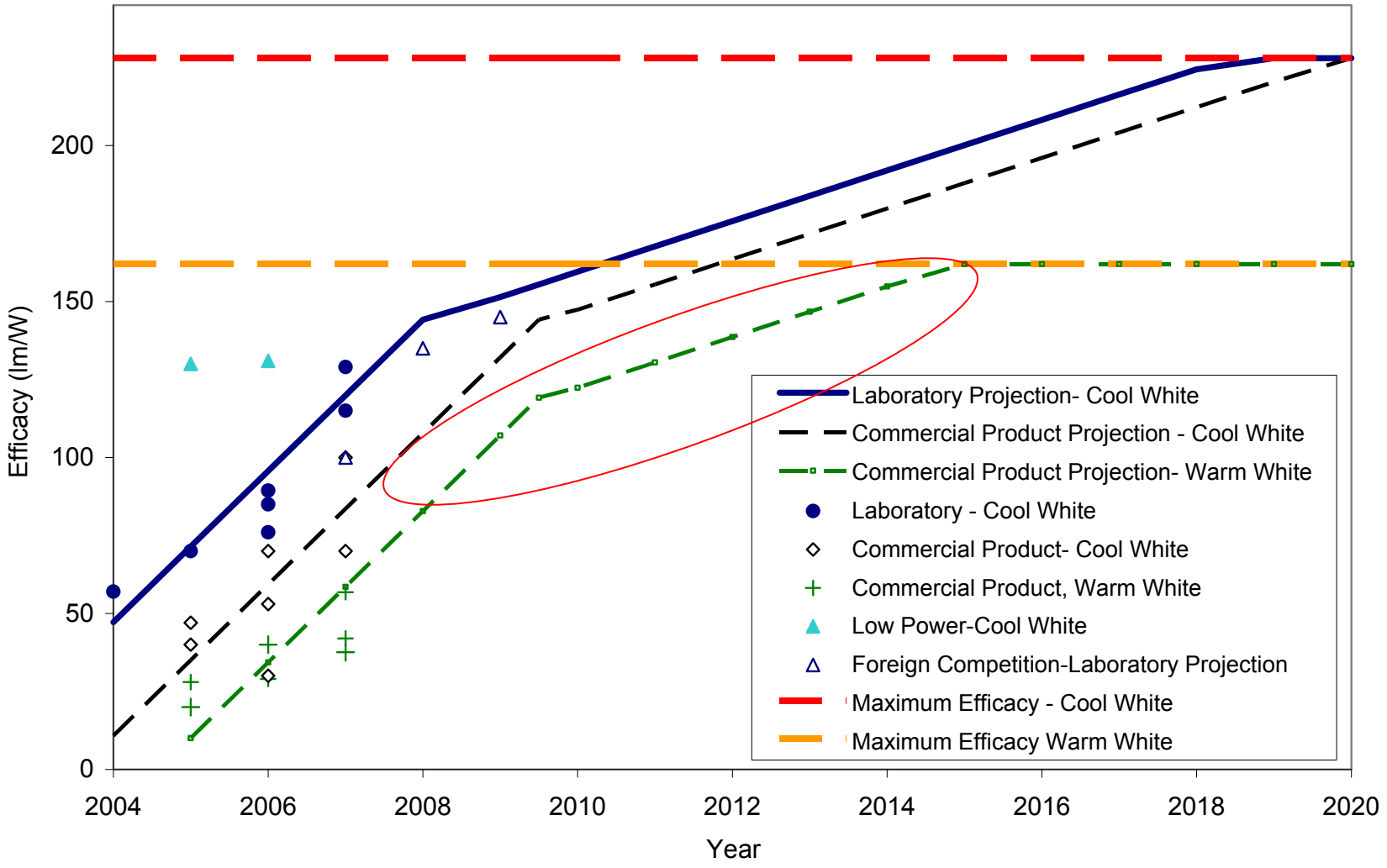
- Steadily improving LED chips
- Better thermal performance
- Manufacturers are announcing new performance records almost every month
- Steady stream of new products
- Immature markets, limited understanding

Efficacy Projections



SSL Laboratory and Commercial Curves, revised May 2006

White Light SSL Efficacy Projections
Mar. 2008 Targets



DOE SSL R&D MYPP, Mar 2008, Fig. 4-7

LED Device Performance Projections

Metric	2007	2010	2012	2015
Efficacy-Lab (lm/W)	120	160	176	200
Efficacy-Commercial Cool White (lm/W)	84	147	164	188
Efficacy-Commercial Warm White (lm/W)	59	122	139	163
OEM Lamp Price-Product ($/klm)	25	10	5	2

US DOE SSL R&D MYPP, March 2008, table 4-2.

LED Luminaire Performance Projections

Metric	2007	2010	2012	2015
Device Efficacy-Commercial Cool White (lm/W, 25 degrees C)	84	147	164	188
Efficacy-Commercial Warm White (lm/W)	59	122	139	163
Thermal Efficiency	85%	89%	91%	95%
Efficiency of Driver	85%	89%	91%	95%
Efficiency of Fixture	77%	84%	88%	95%
Resultant luminaire efficiency	56%	66%	73%	86%
Luminaire Efficacy-Commercial Cool White (lm/W)	47	97	121	161
Luminaire Efficacy-Commercial Warm White (lm/W)	33	80	101	140

US DOE SSL Multi-Year Program Plan, March 2008, table 4-11.

New, improved products appearing regularly

Beta Lighting

Finelite

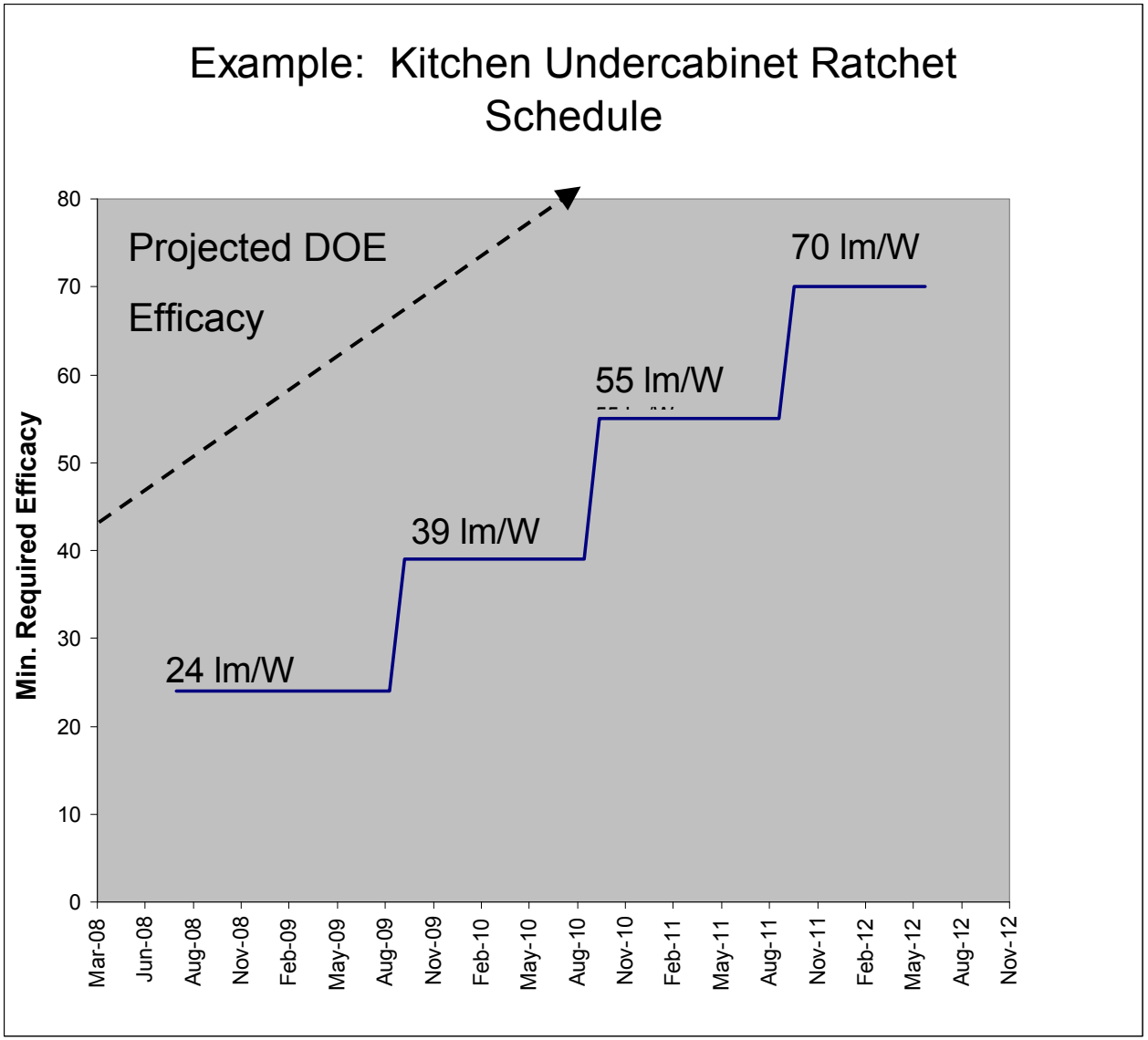
LLF

Progress

Planned Efficacy Ratchet

- Technology is changing too fast to maintain existing efficacy requirements for extended period
- Given rapid observed and projected efficacy improvements, DOE plans to adopt a schedule of future min. efficacy increases
- Maintain viability of the ENERGY STAR label

Example Efficacy Ratchet



Expansion of Category A

- DOE has announced plans to add additional applications to Category A:
  - Street and area lighting
  - Parking garage lighting
  - Cove lighting
  - Ceiling lighting
  - Replacement lamp applications
  - Display and accent lighting
  - Wall-wash applications
  - Considering others

Process for Determining Additional Cat. A Applications

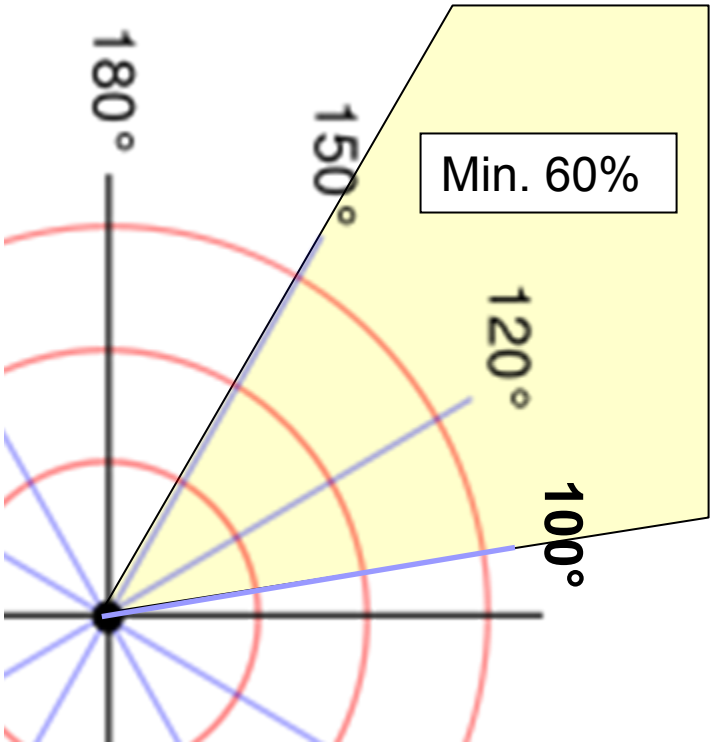
- Benchmark existing technology performance
- Determine suitability for LEDs given the current state of LED technology
  - CALiPER
  - Industry Standard LM-79-80 test reports
- Evaluate cost effectiveness
- Establish draft criteria that “bounds” performance to ensure high quality products
- Provide stakeholder review and comment opportunities

Asymmetric Cove Lighting

- Asymmetric Cove Lighting illuminates ceilings providing indirect lighting to the space
- Light needs to leave the luminaire at right angles projecting horizontally on the ceiling
- Current technology
  - T5/T5HO and T8 linear fluorescent
- Average luminaire efficiency is ~65%

Asymmetric Cove Lighting

- **Minimum Light Output**
  - 400 lumens per lineal foot
- **Zonal Lumen Density**
  - Min. 60% in 100-150° zone
- **Luminaire Efficacy**
  - ≥ 56 lm/W
- **CCTs limited to:**
  - 2700 - 5000K



So What's Next?

- Efficacy Ratchets
  - Concerns were raised during the May 15 Stakeholder Workshop
  - DOE will engage the industry as to how best to transition from Cat. A to Cat. B
- Category A Additions
  - DOE will release the draft additions shortly
  - All stakeholder's will be provided a review and comment period
  - At completion of review DOE will establish the effective date

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