

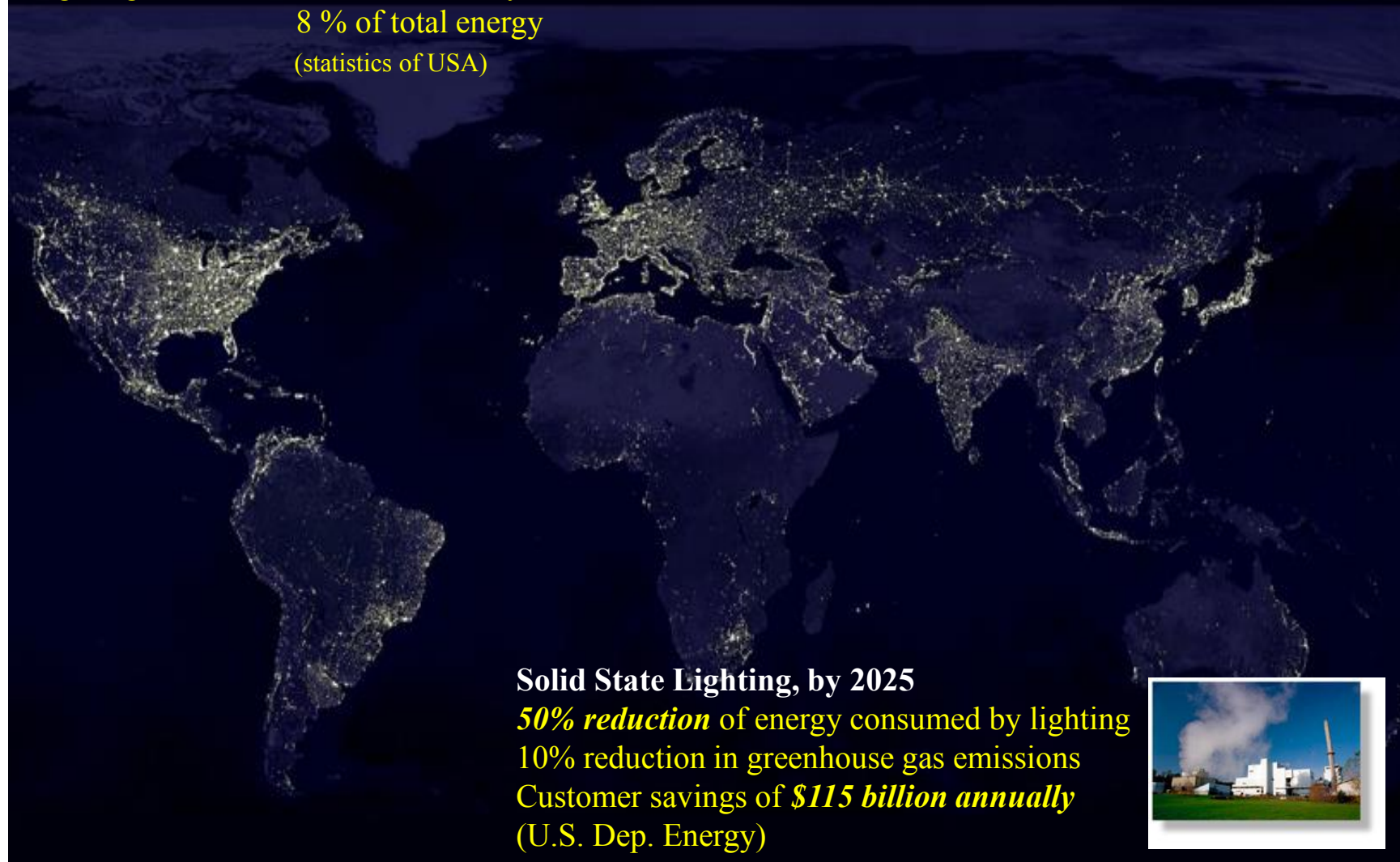
Training Workshop on Building Energy Efficiency Systems and Labelling
October 26-28, 2015

Truth in Solid-state Lighting Labelling

C. Cameron Miller

National Institute of Standards & Technology

Lighting consumes 22 % of electricity
8 % of total energy
(statistics of USA)



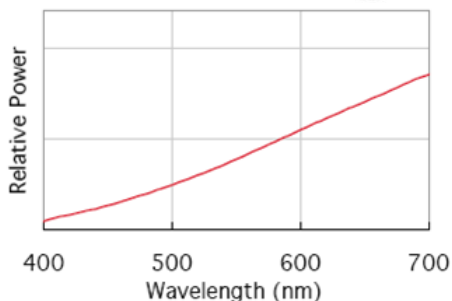
Solid State Lighting, by 2025

50% reduction of energy consumed by lighting
10% reduction in greenhouse gas emissions
Customer savings of **\$115 billion annually**
(U.S. Dep. Energy)



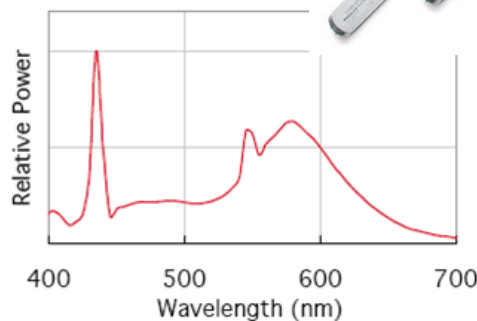
Solid-state Lighting Technology

Incandescent



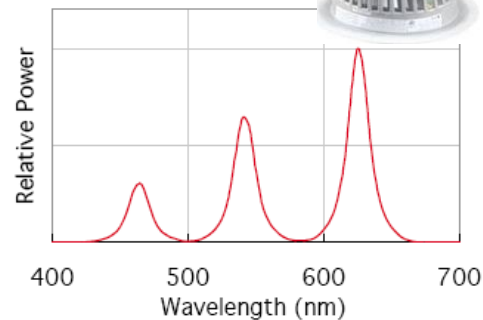
15 lm/W

Fluorescent



90 lm/W

Solid-state



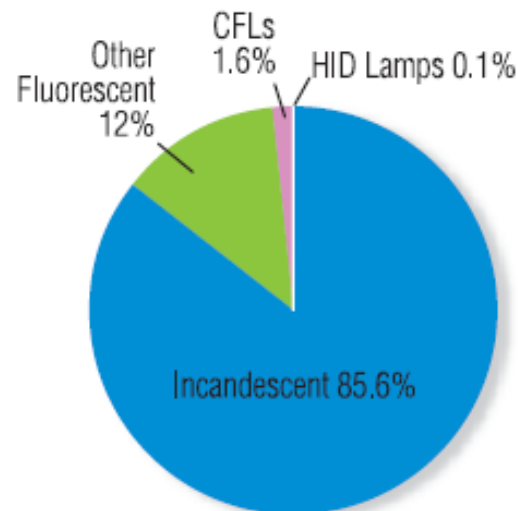
Potential: 250 lm/W



CFLs in America: Lessons Learned
on the Way to the Market
DOE Report

After 30 years

- eye strain
- noise
- green skin tones
- institutional



Q

Lighting Facts Label (DOE)

Partner & Product Count

Manufacturers 550

2007 Energy Independence and Security Act

100 W, 75 W, 60 W, and 40 W incandescent bulbs are no longer produced in America. (halogen incandescent bulbs will still be produced.)

Reg



(Products monitoring)

Standardization



Research

National Institute of Standards and Technology

NIST, industry, academia

testing program & other ABs

Prof. Testing (NIST)

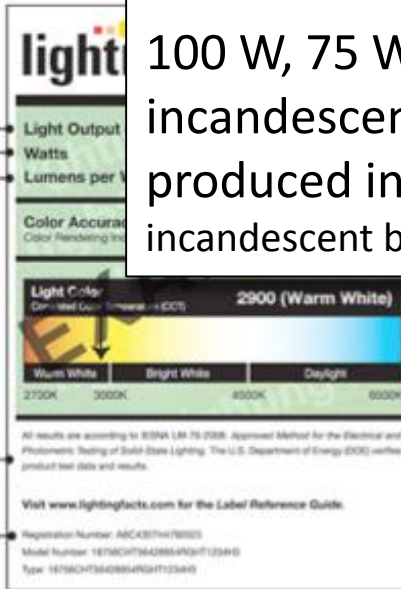
Light Output/Lumens
Measures light output. The higher the number, the more light is emitted.
Reported as "Total Integrated Flux (Lumens)" on LM-79 test report.

Watts
Measures energy required to light the product. The lower the wattage, the less energy used.
Reported as "Input Power (Watts)" on LM-79 test report.

Lumens per Watt/Efficacy
Measures efficiency. The higher the number, the more efficient the product.
Reported as "Efficacy" on LM-79 test report.








IESNA LM-79-2008
Industry standardized test procedure that measures performance qualities of LED luminaires and integral lamps. It allows for a true comparison of luminaires regardless of the light source.

Registration Number
Model Number
Type

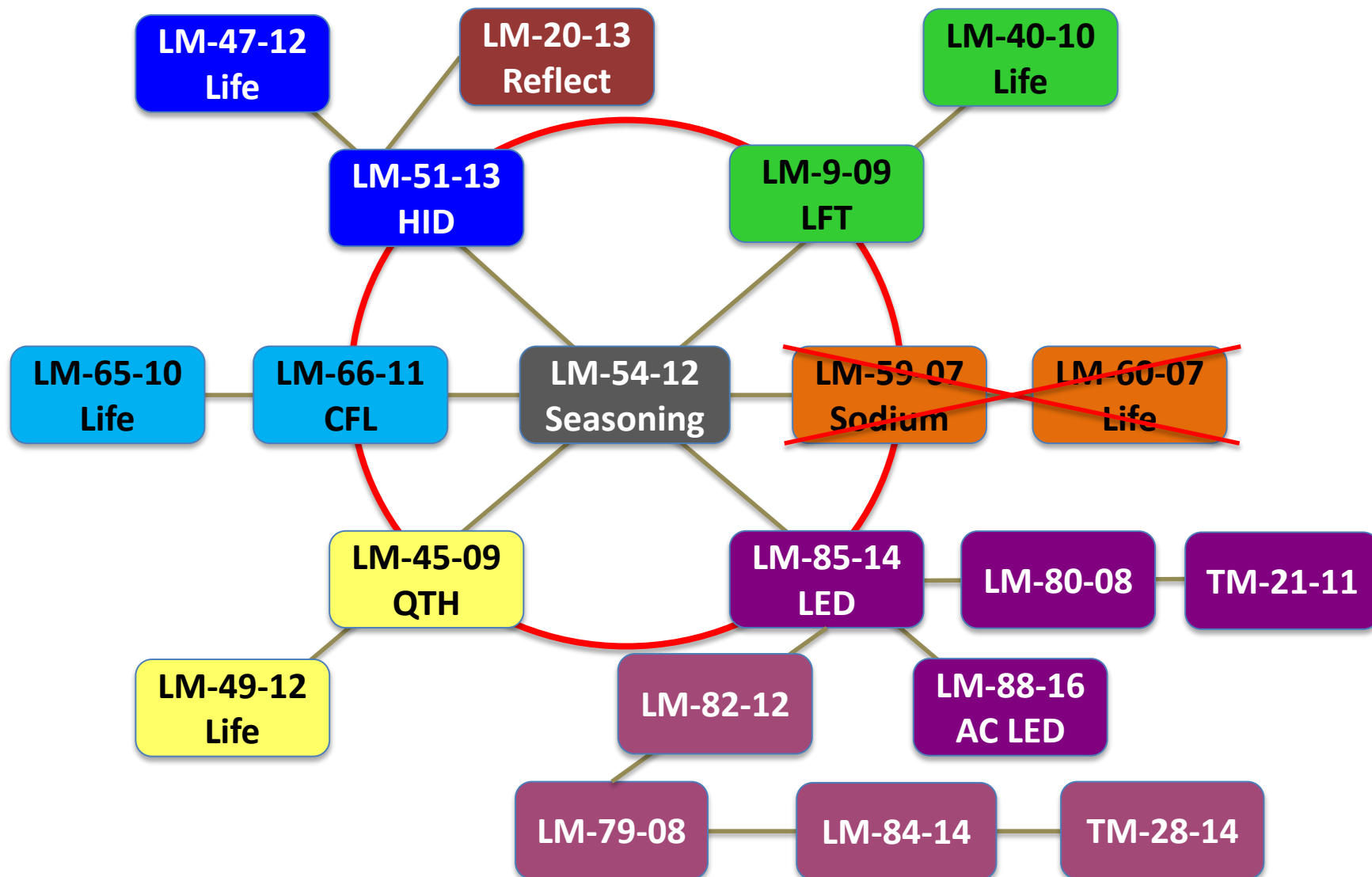


Correlated Color Temperature (CCT)
Measures light color.
"Cool" colors have higher Kelvin temperatures (5000-6500 K); "warm" colors have lower color temperatures (2700-3000 K). Color temperatures higher than 6500 are outside of the defined region for white light, but may be appropriate for outdoor applications.

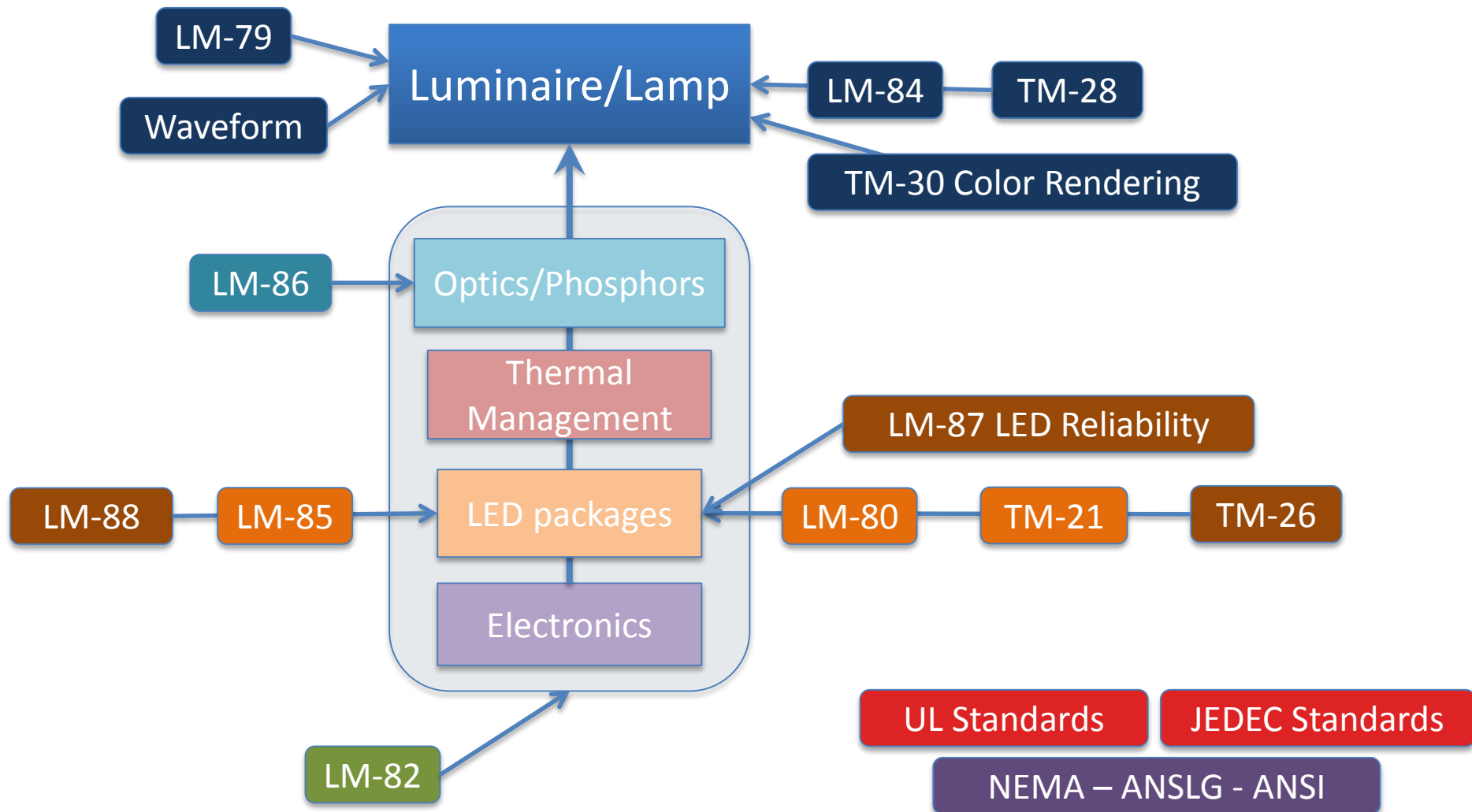
Standards development for solid-state lighting

Fundamental Definitions	Measurement, Lighting appl.	Performance, compatibility of products	Safety	Driver and EMC	Technology assistance
<div></div>	<div></div>	<div></div>			US DOE PNNL
		<div></div>			NEMA
		<div></div>	<div></div>		NGLIA
					ASSIST
					NIST
					Manufacturers

Lighting standards (all technologies)



Solid-state lighting standards



IES LM-79 Approved method for electrical and photometric measurement of SSL products



IES LM-79-08

Approved Method: **Electrical and Photometric Measurements** of Solid-State Lighting Products

Prepared by the IES Testing Procedures Committee

Solid-State Lighting Subcommittee

Kevin Dowling, Chair
Yoshi Ohno, Technical Coordinator

- The first test method for SSL products in the world, published in 2008.
- Used by **Energy Star, Lighting Facts, and many other government programs.**
- Reference for **NVLAP SSL Testing Accreditation program**
- Covers LED luminaires and integrated LED lamps.
- Covers measurements of
 - Total luminous flux (lumen)
 - Luminous efficacy (lm/W)
 - Chromaticity, CCT, CRI
 - Luminous intensity distribution
- Major contribution by NIST



Published 2008, Revision in progress (2016)

IES LM-80 & TM-21 – Lumen maintenance



IES TM-21-11

Projecting Long Term Lumen Maintenance of LED Light Sources

Prepared by:
The Subcommittee on Solid State Lighting of
the IES Testing Procedures Committee

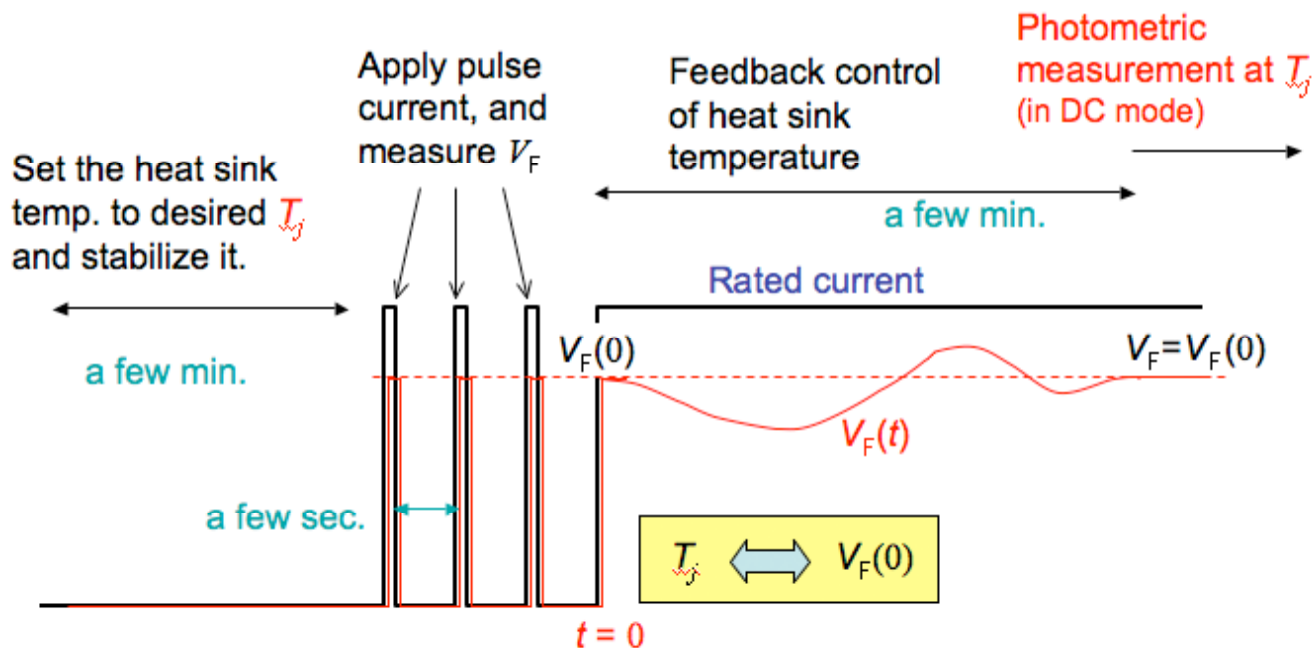
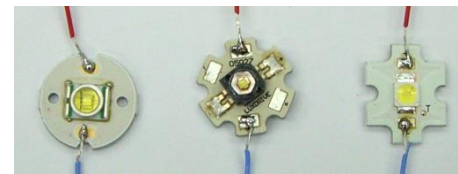


IES LM-85 – LED package measurement



DC operation measurement

- Using a step full DC current
- Using multiple short current pulses before a step full current
- Extrapolating $V_f(0)$ using a step full current



Accreditation and proficiency testing

- Laboratory Accreditation
 - SSL program was required for Energy Star and Lighting Facts labeling program
 - Assessor Training – February 7, 2008
 - DOE sponsored Laboratory Training
 - February 16-17, 2010
 - 34 laboratory representatives
- Establish a proficiency testing program
 - At request of the EPA, PT program was opened to customers of other accrediting bodies

NIST HANDBOOK 150-1A
2009 Edition



National
Voluntary
Laboratory
Accreditation
Program

**ENERGY EFFICIENT
LIGHTING PRODUCTS –
SOLID STATE LIGHTING**

C. Cameron Miller
Lawrence I. Knab
Ambler Thompson
Jon Crickenberger

Combined 150-1 and 150-1A in 2010 Edition

SSL proficiency test - artifacts

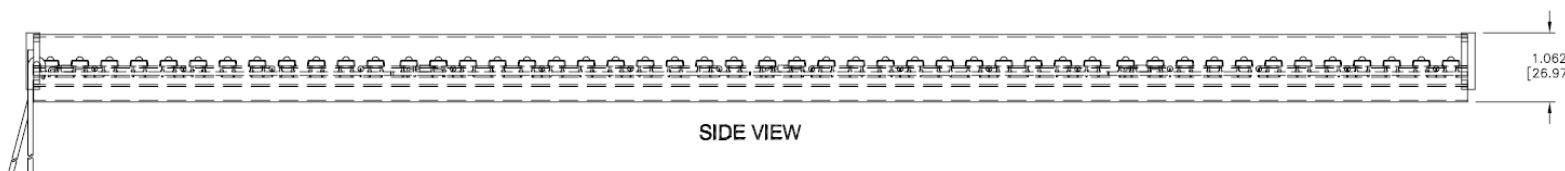
- Six items

Incandescent lamp (120 V AC)

Under cabinet SSL luminaire

(12 V DC, DC current controlled)

Four different white SSL lamps (120 V AC)



Proficiency test – Version 1

- 118 laboratories have participated

United States (49)

China (45)

Taiwan (9)

Korea (4)

Canada (3)

Netherlands

Brazil

Singapore

India

Malaysia

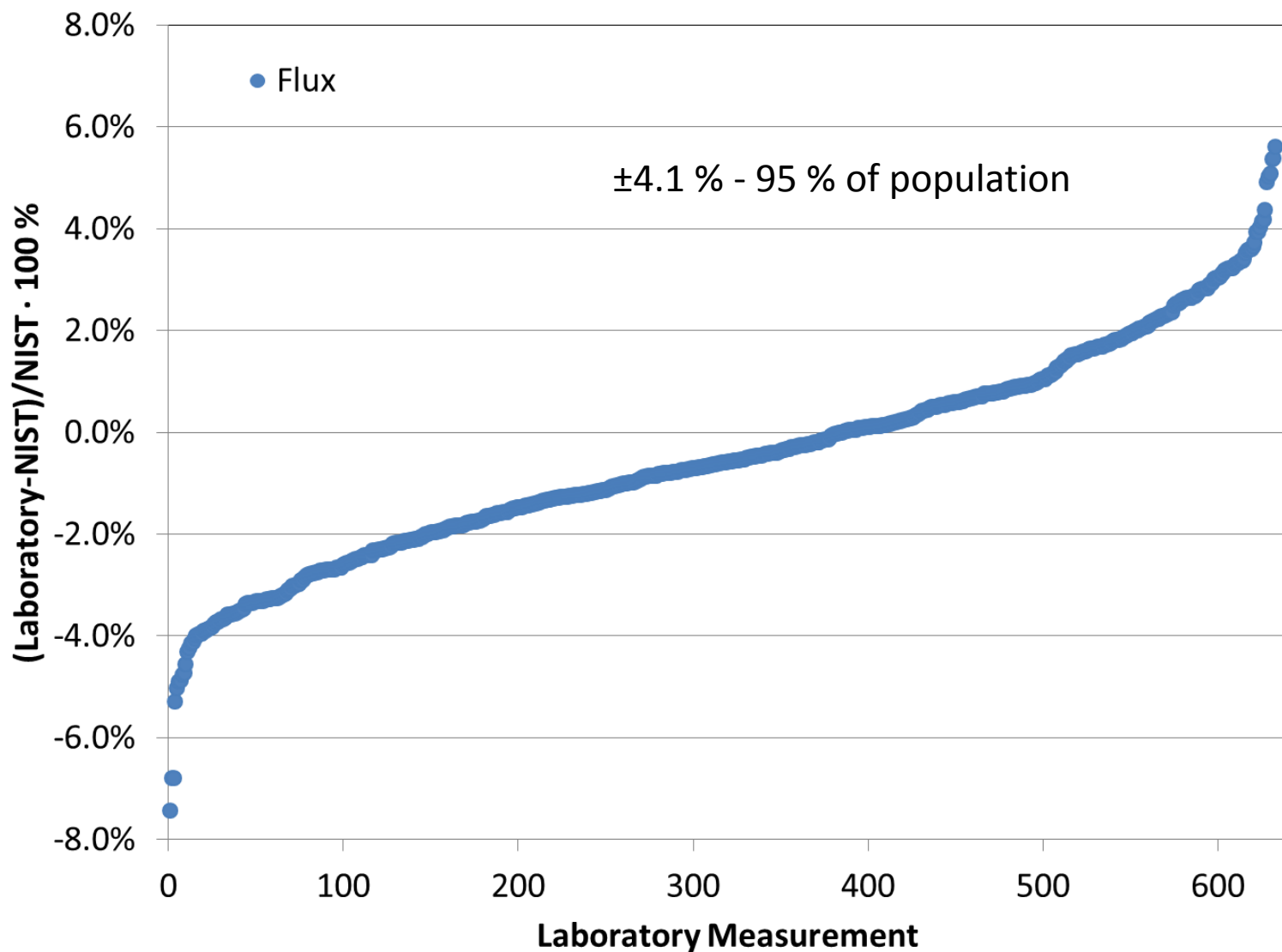
Hungary

Italy

Germany

SSL-MAP1 officially closed on January 1st, 2015

Overall results - flux



Proficiency test – Version 2

- New version (2.0) released Jan 1st 2015
- Mandatory lamps



120 V AC

120 V AC



120 V AC

12 V AC
12 V DC



120 V AC

- Non-mandatory lamps



12 V AC
12 V DC
4.2 A



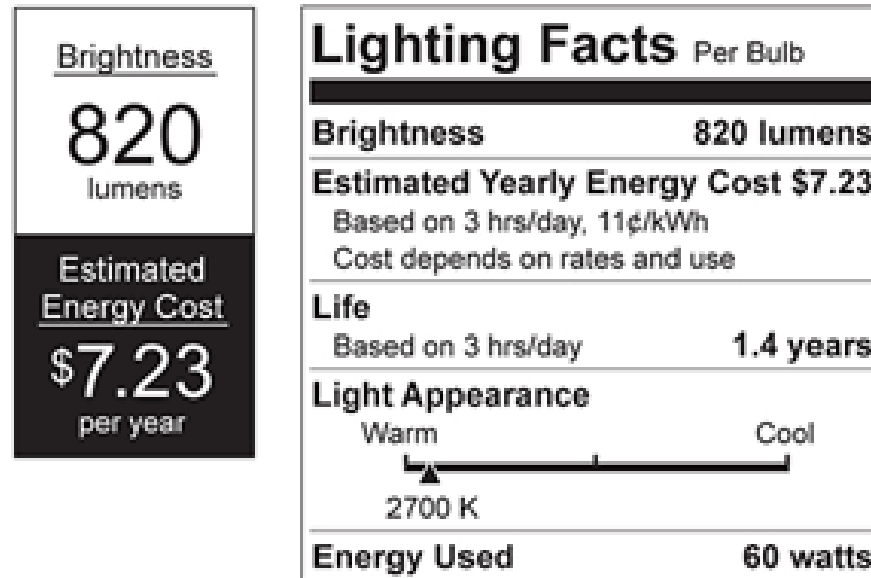
120 V AC



Option
120 V AC

Federal Trade Commission (FTC) labels

LED lamps only



<https://www.ftc.gov/tips-advice/business-center/guidance/ftc-lighting-facts-label-questions-answers-manufacturers>

Energy Star – Lamps & Luminaires



Lamps V1.1 (V2.0 in preparation)

- Common specifications for all lamp technologies
- Omnidirectional, Directional, Decorative
- Minimum lm/W and minimum light output
 - Omnidirectional 55 lm/W (<15 W), 65 lm/W (≥ 15 W)
 - Directional 40 lm/W (< 20 W), 50 lm/W (>20 W)
 - Decorative 45 to 60 lm/W
- Chromaticity: ANSI C78.377-2011 for LED products
- Color quality (CRI Ra >80)
- Lumen maintenance LM-80/TM-21

Luminaire V2.0 (EPA) May 4, 2015.

- Common specifications for LED luminaires and FL luminaires
- Non-directional Minimum 65 lm/W
- Directional luminaire minimum 50 to 70 lm/W
- Chromaticity: ANSI C78.377 for LED products
- Color quality (CRI Ra >80, R9>0)
- Lifetime (L70 >25,000 h indoor, 35,000 h outdoor)

US DOE rule making on SSL products



FEDERAL REGISTER

Vol. 80 Thursday,
No. 131 July 9, 2015

DEPARTMENT OF ENERGY

10 CFR Parts 429 and 430

[Docket No. EERE-2011-BT-TP-0071]

RIN 1904-AC67

Energy Conservation Program: Test Procedures for Integrated Light-Emitting Diode Lamps

AGENCY: Office of Energy Efficiency and Renewable Energy, Department of Energy.

ACTION: Supplemental notice of proposed rulemaking.

SUMMARY: This supplemental notice of proposed rulemaking (SNOPR) proposes a test procedure for light-emitting diode (LED) lamps (hereafter referred to as

LED lamps) to support the implementation of labeling provisions by the Federal Trade Commission (FTC),

as well as the ongoing general service lamps rulemaking, which includes LED lamps. The SNOPR proposes test

procedures for determining the lumen output, input power, lamp efficacy, correlated color temperature (CCT), color rendering index (CRI), power factor, lifetime, and standby mode power for LED lamps.

SUPPLEMENTARY INFORMATION:

DOE proposes to incorporate by reference the following industry standards into 10 CFR part 430.

1. **ANSI /IES RP-16-2010,**
2. **IES LM-79-08,** “Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products.”
3. **IES LM-84-14,** “Approved Method: Measuring Luminous Flux and Color Maintenance of LED Lamps, Light Engines, and Luminaires.”
4. **IES TM-28-14,** “Projecting Long-Term Luminous Flux Maintenance of LED Lamps and Luminaires.”

California Energy Commission – Final report

VOLUNTARY CALIFORNIA QUALITY LIGHT-EMITTING DIODE (LED) LAMP SPECIFICATION

A Voluntary Minimum Specification for “California
Quality” LED Lamps



CALIFORNIA
ENERGY COMMISSION
Edmund G. Brown Jr., Governor

DECEMBER 2012
CEC-400-2012-016-SF

Design Light Consortium (DLC)

<https://www.designlights.org>



The DesignLights Consortium™ promotes quality, performance and energy efficient commercial sector lighting solutions through collaboration among its federal, regional, state, utility, and energy efficiency program members, luminaire manufacturers, lighting designers, and other industry stakeholders throughout the US and Canada. The DLC is a project of Northeast Energy Efficiency Partnerships (NEEP), a regional non-profit which has been bringing stakeholders together since 1996 to accelerate efficiency solutions to create lasting change in the marketplace.

Design Light Consortium (DLC)

Technical Requirements Table, V3.0

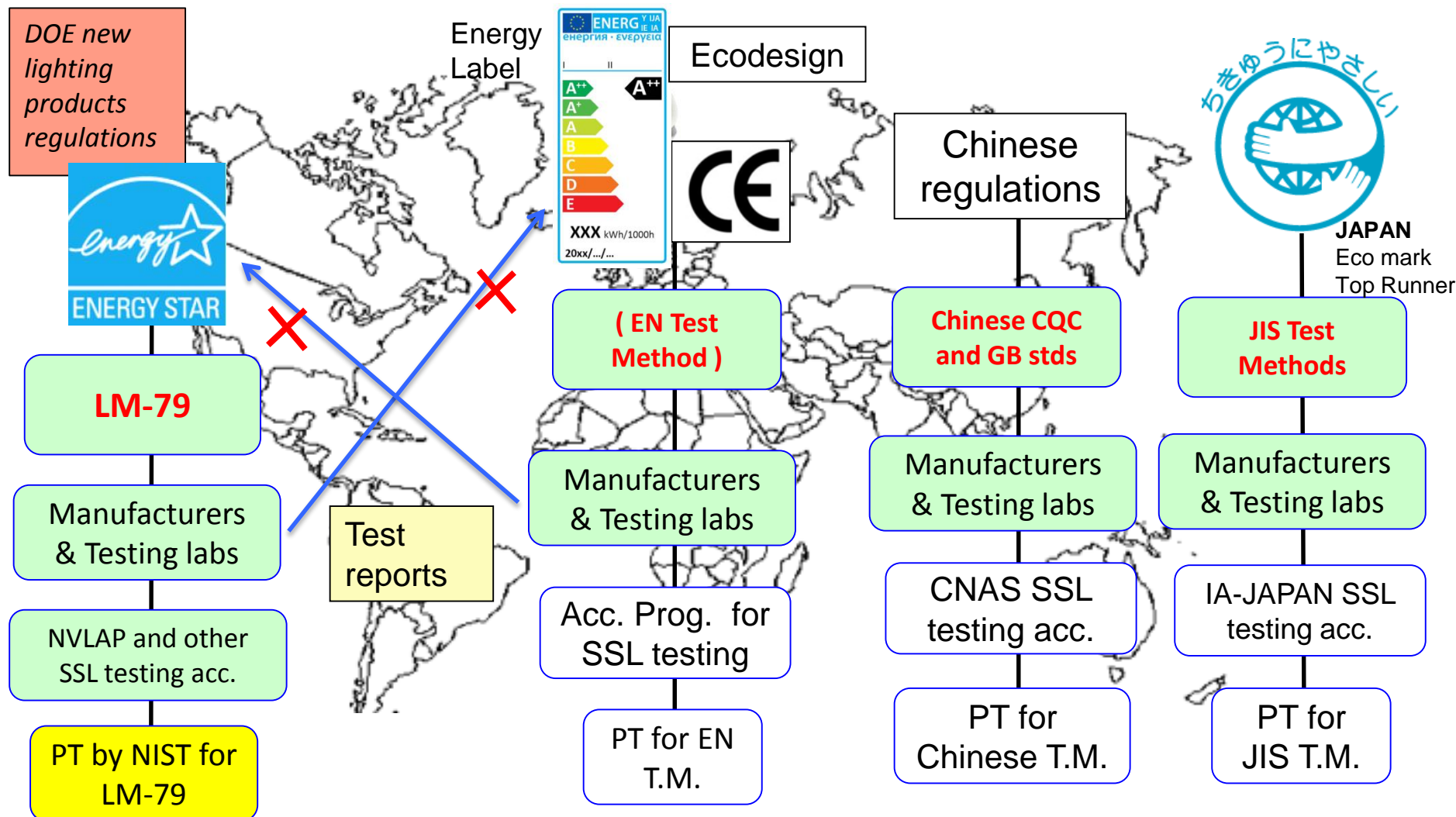
Technical Requirements: Luminaires

#	Category	General Application	Requirements							Primary Use**
			Minimum Light Output (lm)	DLC Standard			DLC Premium*			
				Minimum Efficacy (lm/W)	Minimum Warranty (years)	CCT / CRI / L ₇₀	Minimum Efficacy (lm/W)	Minimum Warranty (years)	CCT / CRI / L ₉₀ /L ₇₀	
1	Outdoor	Outdoor - Low Output	250-5,000	65	5	≤5700 / ≥65 / ≥50,000	100	5	≤5700 / ≥65 / >36,000 /≥50,000	<ul style="list-style-type: none">• Outdoor Pole/Arm-mounted Area and Roadway Luminaires• Outdoor Pole/Arm-mounted Decorative Luminaires• Outdoor Wall-mounted Area Luminaires• Bollards• Parking Garage Luminaires• Fuel Pump Canopy Luminaires• Landscape/Accent Flood and Spot Luminaires• Architectural Flood and Spot Luminaires• Stairwell and Passageway Luminaires• Specialty:
2		Outdoor - Mid Output	5,000-10,000	70			105			
3		Outdoor - High Output	≥10,000	75			110			

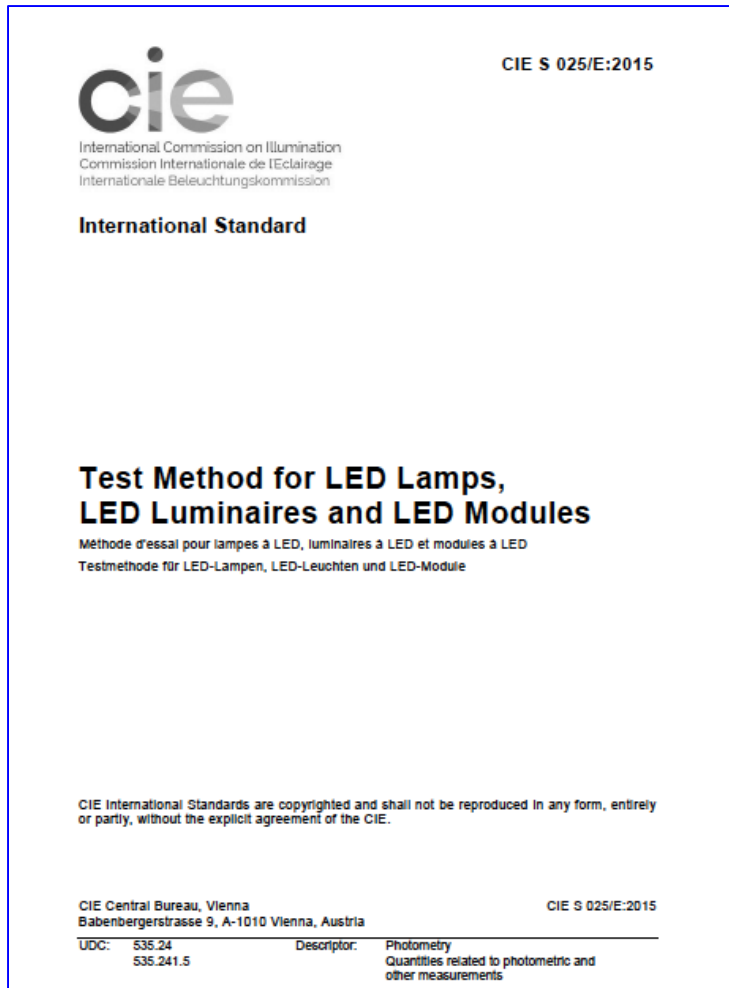
Testing Laboratory Requirements

DLC applications require that product testing be conducted at an accredited laboratory appropriate for the performance being evaluated. These tests include the *IES-LM-79-08 Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products*, In-situ Temperature Measurement Tests (ISTMT), *IES-LM-80-08 Approved Method: Measuring Lumen Maintenance of LED Light Sources*, and *IES-LM-84-14 Approved Method:*

International harmonization in SSL testing and accreditation



CIE S025 Test method for LED lamps, LED modules, and LED luminaires



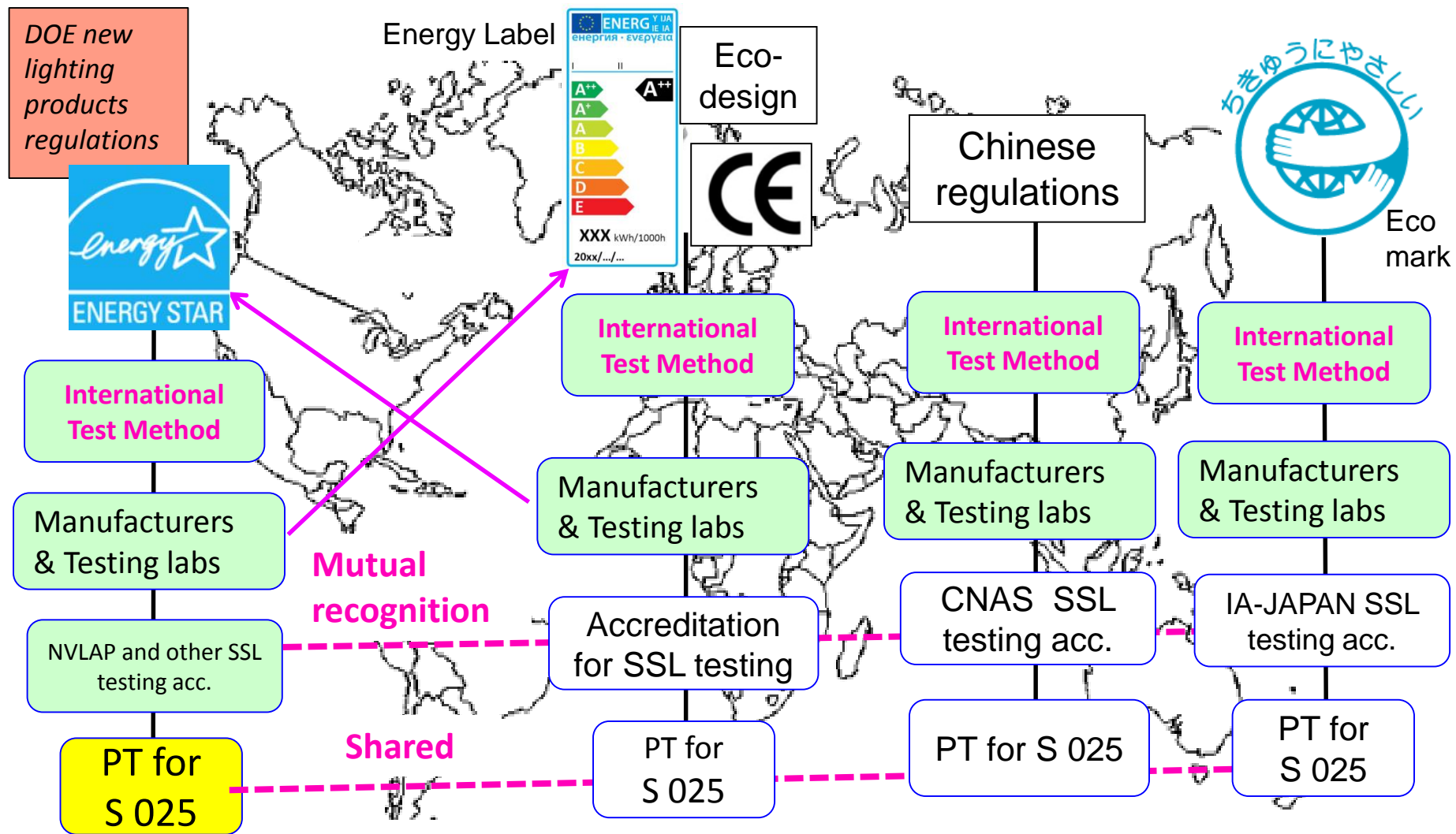
Published in March 2015.

S 025 provides a unified global test method for harmonisation of testing of LEDs and SSL products worldwide

Collaboration of
**CIE TC2-71 (Y. Ohno, chair) and
CEN TC169 WG7 (G. Vandermeersch, chair)**

European standard published same time:
**EN 13032 Lighting Applications —
Measurement and presentation of
photometric data of lamps and luminaires —
Part 4: LED lamps, modules and luminaires**

International goal for SSL testing and accreditation



Thank you