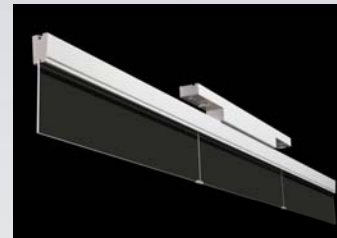


Power Planning Challenges in a Fast Market

Conservation Resources Advisory Committee
November 2013



Outline

- **Outline key trends in SSL & pace of change**
 - Overview
 - Market forecasts
 - Trend Analysis
- **Discuss implications on forecast & CPA**
- **Discuss approaches for Seventh Plan**

Seventh Plan Issues

- Include forecast cost trends beyond 2015?
- Estimating pace of market uptake
- Near-term technology innovation
- Estimating old system turnover rates in face of new technology

Take these issues up at Conservation Resource Advisory Committee (CRAC)

Overview

Key Sources

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

BUILDING TECHNOLOGIES PROGRAM

Energy Savings Potential of Solid-State Lighting in General Illumination Applications

January 2012

January 2012

Prepared for:
Solid-State Lighting Program
Building Technologies Program
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy

Prepared by:
Navigant Consulting, Inc.

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Adoption of Light-Emitting Diodes in Common Lighting Applications

April 2013
Revised May 2013

May 2013

Prepared for:
Solid-State Lighting Program
Building Technologies Office
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy

Prepared by:
Navigant

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

BUILDING TECHNOLOGIES OFFICE

SSL Pricing and Efficacy Trend Analysis for Utility Program Planning

October 2013

October 2013

Prepared for:
Solid-State Lighting Program
Building Technologies Office
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy

Prepared by:
Pacific Northwest National Laboratory

Key Findings

1. Rapid Technology Evolution
2. Rapid Industry Evolution
3. Rapid Customer Uptake
4. Forecast Rapid Improvement
 - Efficacy
 - Cost
 - Market Penetration

Pace of Change

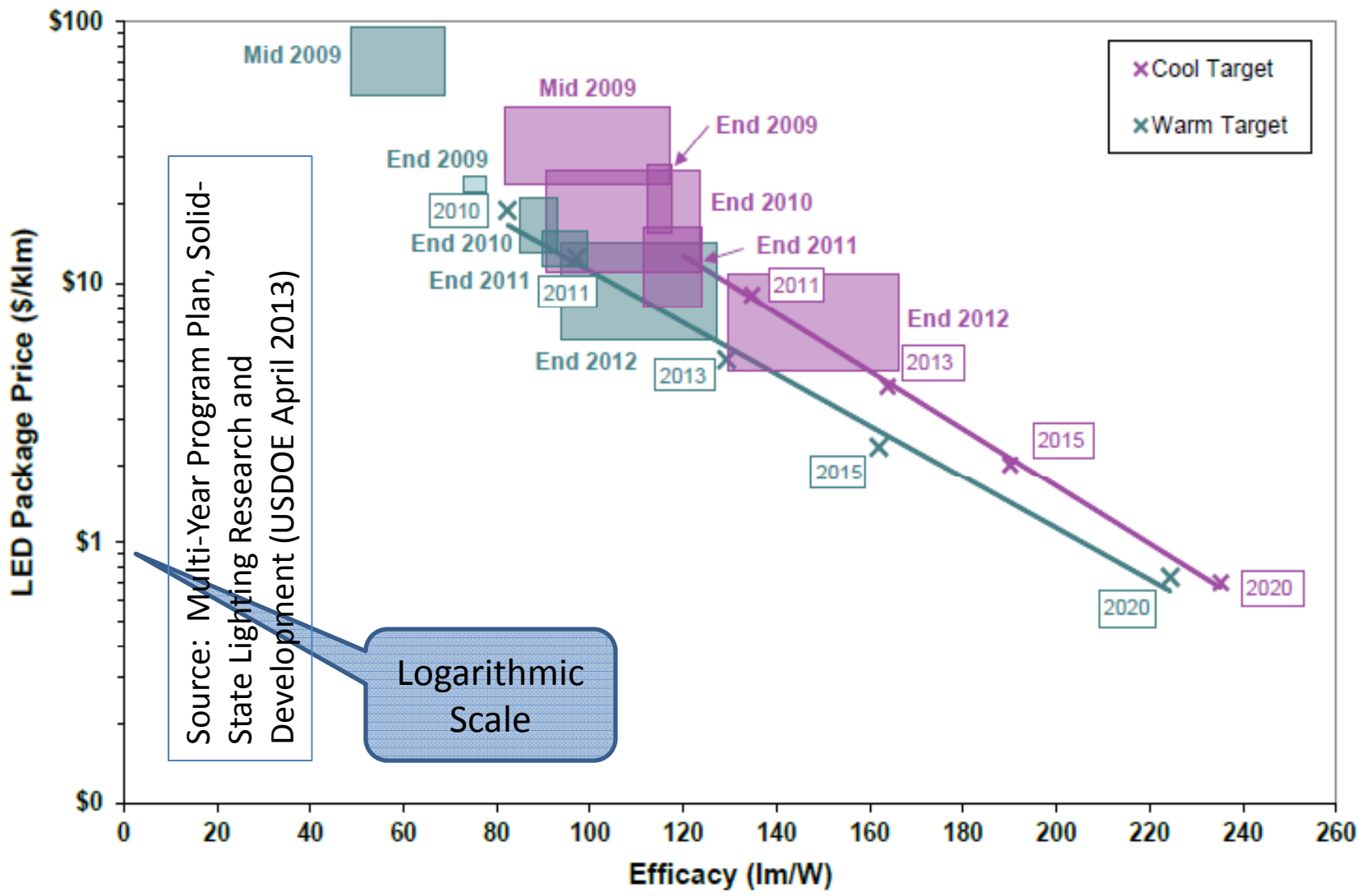


FIGURE 2.5 PRICE-EFFICACY TRADEOFF FOR LED PACKAGES AT 35 A/CM² AND 25 °C

Select Best-In-Class Incumbent Comparison 2013

In Efficacy:

LED products are challenging some Best-In-Class incumbent technologies.

But it's not all about efficacy:

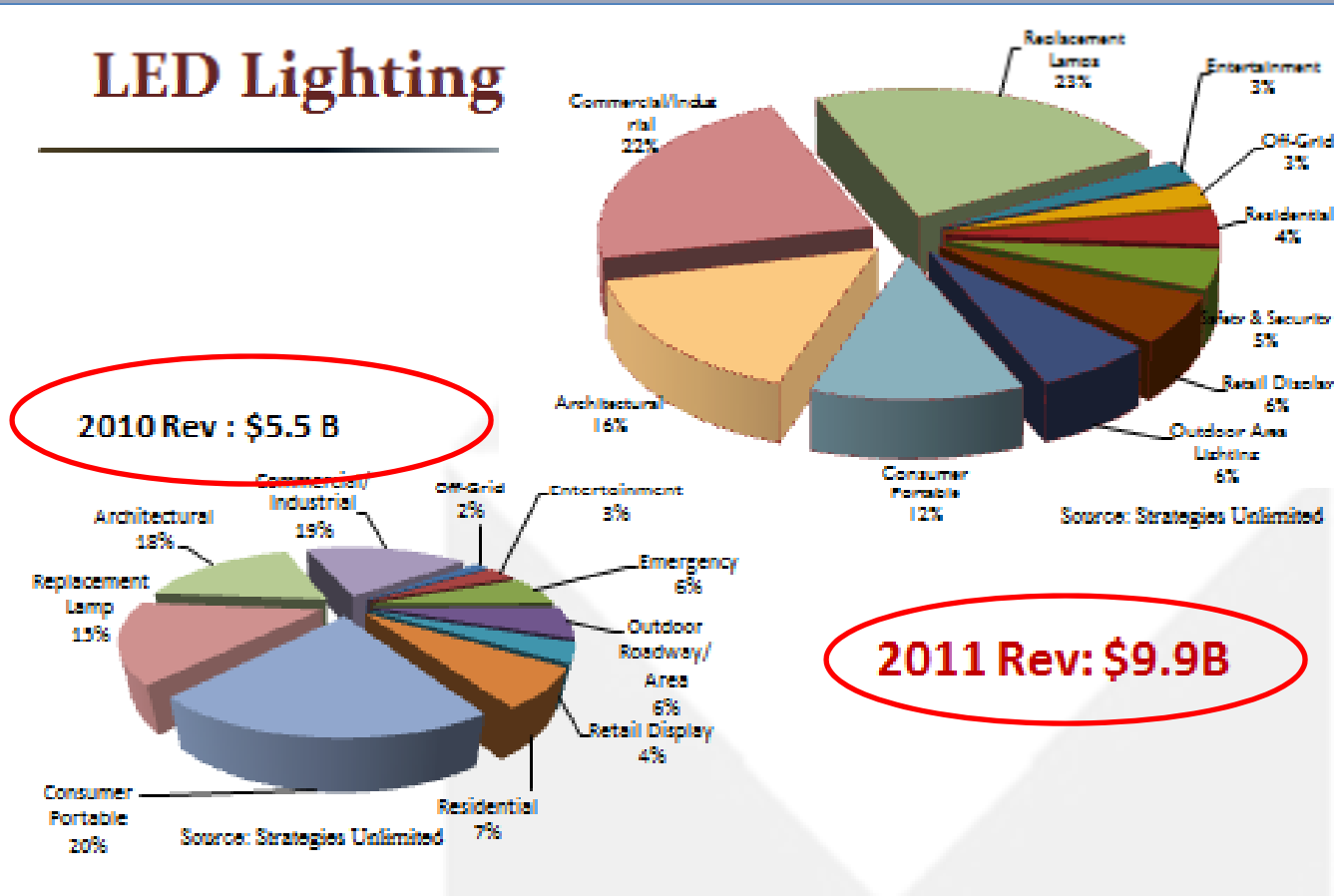
- Cost
- Life
- Output
- Color
- Maintenance

Form Factor	Incumbent Technology	Best 2013 Incumbent Efficacy (lm/Watt)	Best 2013 LED Efficacy (lm/Watt)
A-19 bulb	Halogen IR	30	94
A-19 bulb	CFL	70	94
PAR-38 bulb	Halogen IR	26	89
MR-16 Bulb	Halogen IR	20	77
Candelabra	Incandescent	10	80
Downlight	CFL	40	88
4-Foot Linear Pendant	Linear Fluor	90	119
2x2 Recessed Troffer	U-Bent Fluor	50	90
High Bay	Metal Halide	100	110
Streetlight	HPS	75	110

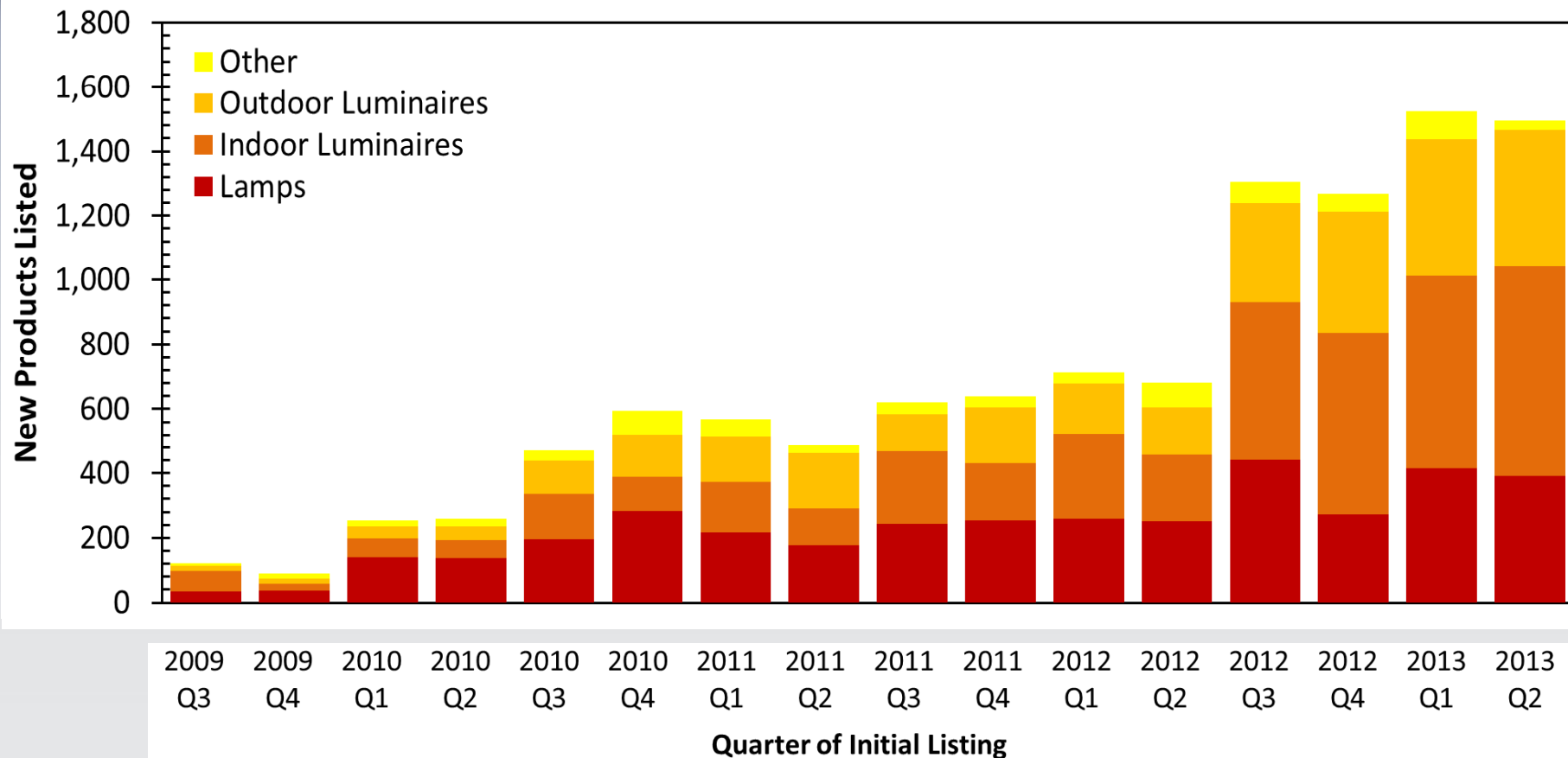
Industry Revenues Growing

Strategies Unlimited forecast industry revenue of \$22 Billion by 2016

LED Lighting



LED Product Count On the Rise



Saturation in Two Years

Source: Multi-Year
Program Plan, Solid-
State Lighting
Research and
Development
(USDOE April 2013)



TABLE 2.1 U.S. PREVALENCE OF LED SOURCES IN SELECT LIGHTING APPLICATIONS [20, 1]

Application	Estimated LED Penetration of Installed Stock (%) ¹	
	2010	2012
A-Type	-	<1
Directional	<1	5
MR16	3	10
Decorative	-	<1
Downlight	<1	<1
Troffer	-	-
High-Bay	-	<1
Parking ²	<1	1
Streetlight ²	1	2

Notes:

1. Values less than 0.1% are considered negligible.
2. These estimates have been updated using data from the 2010 U.S. Lighting Market Characterization report.

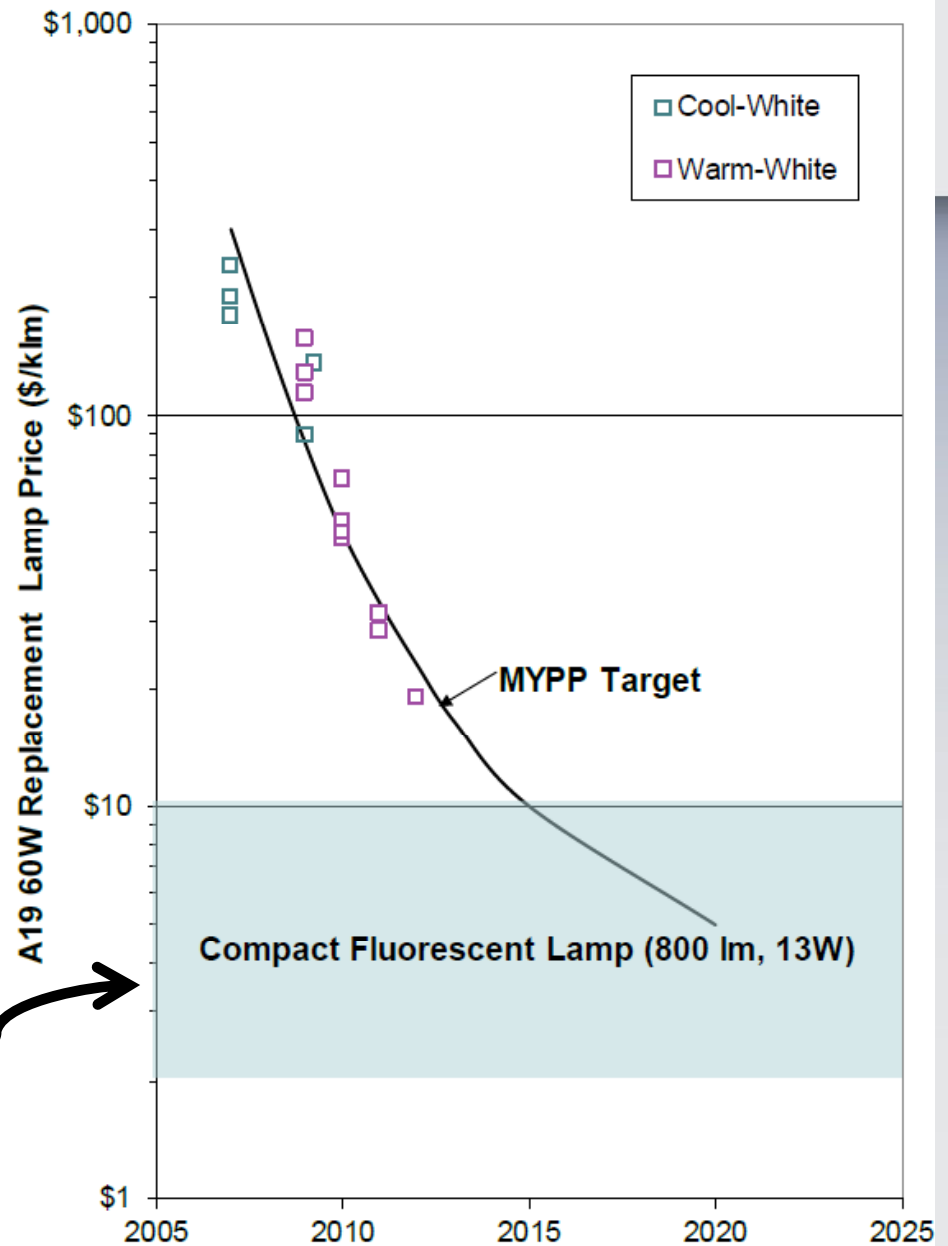
Bulb Cost Trends



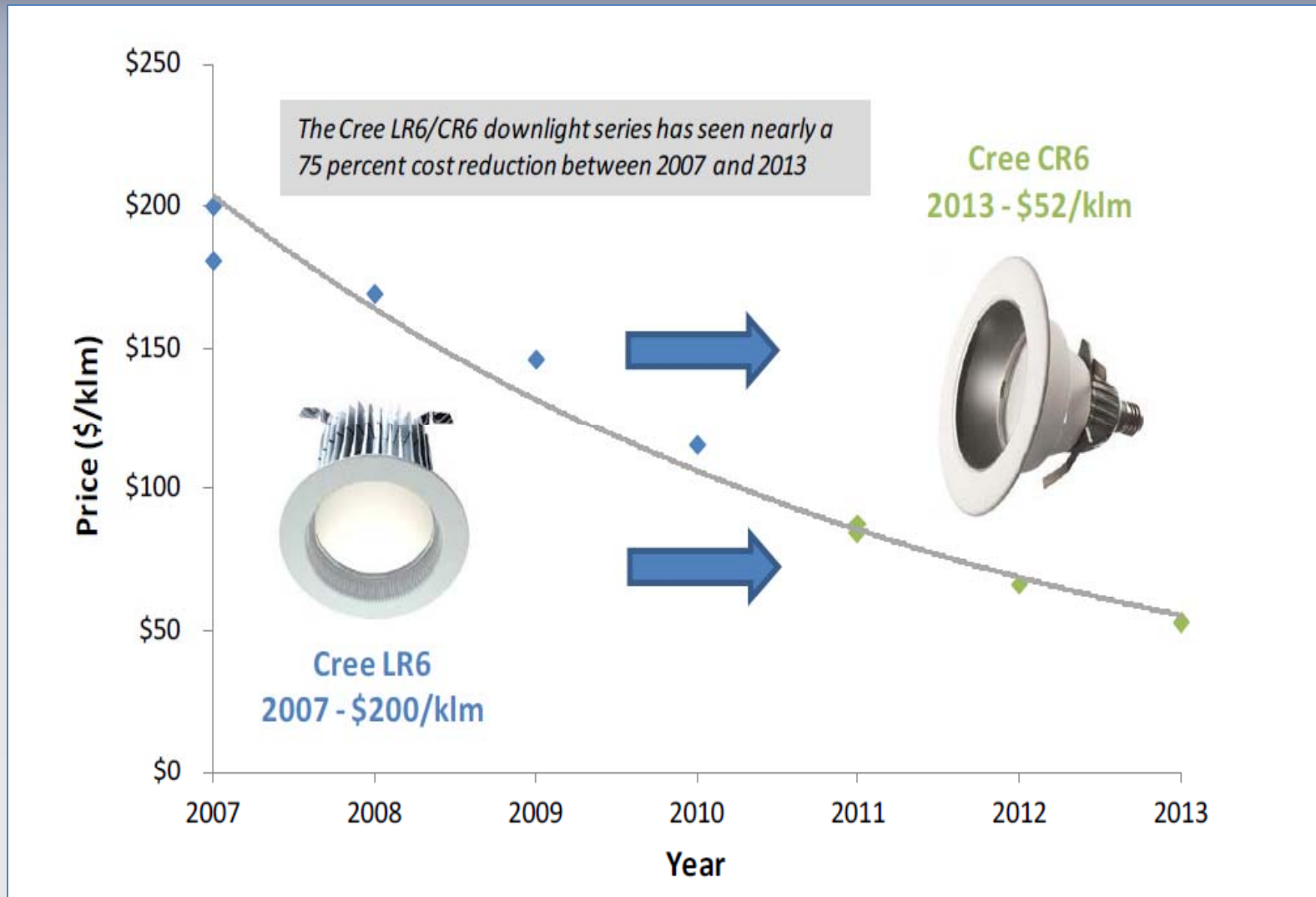
FIGURE 2.6 A19 REPLACEMENT LAMP PRICE PROJECTION (60W EQUIVALENT)

Note: The shaded region illustrates the price range for a typical equivalent performance CFL (13W self-ballasted CFL, non-dimmable at bottom, and dimmable at top).

A halogen incandescent costs about \$2.50/klm today.



Downlight Cost Trends



Streetlight Fixture Cost Trends

Source: City of Los Angeles, Bureau of Lighting

Yearly Comparisons

Local Street LED Fixture

2009

- Avg. Price = \$ 432
- Efficacy = 42 Lm/W
- Life = 80,000 hrs
- Warranty = 5 yrs

2010

- Avg. Price = \$ 298
- Efficacy = 61 Lm/W
- Life = 111,000 hrs
- Warranty = 6 yrs

2011

- Avg. Price = \$ 285
- Efficacy = 72 Lm/W
- Life >150,000 hrs
- Warranty = 6 yrs

2012

- Avg. Price = \$ 245
- Efficacy = 81 Lm/W
- Life >150,000 hrs
- Warranty = 7 yrs



Studies Forecast Significant Penetration of SSL

Table 7.10 Comparison of LED Forecast Model Results

Study	Units	Region	Market Share			
			2010	2011	2015	2020
DOE, 2011	Lumen-hours	U.S.	-	0.6%	10%	36%
Morgan Stanley, 2011	Lumen-hours	World	1%	-	15%	-
McKinsey, 2011	Units	World	1%	-	19%	46%
Stern Agee, 2010	Units	World	0.45%	-	13%	-
IMS Research, 2011	USD	World	10%	-	46%	50%
Cree, 2010	USD	World	5%	-	33%	75%
Philips, 2010	EUR	World	-	8%	50%	-

USDOE: Forecast Lumens by Source

Source: Energy Savings Potential of Solid-State Lighting in General Illumination Applications, USDOE/EERE January 2012

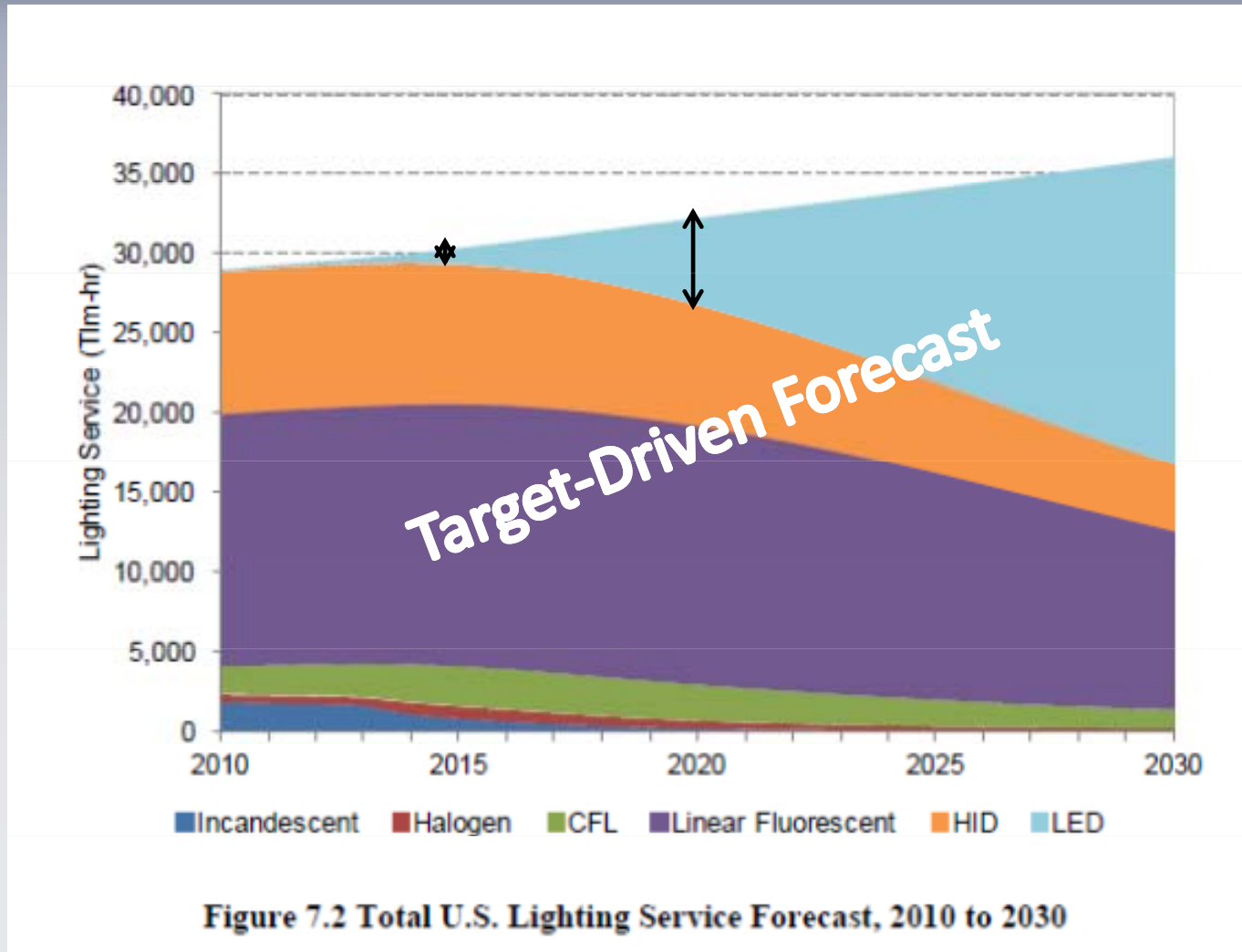


Figure 7.2 Total U.S. Lighting Service Forecast, 2010 to 2030

USDOE: Forecast Big Savings

Source: Energy Savings Potential of Solid-State Lighting in General Illumination Applications, USDOE/EERE January 2012

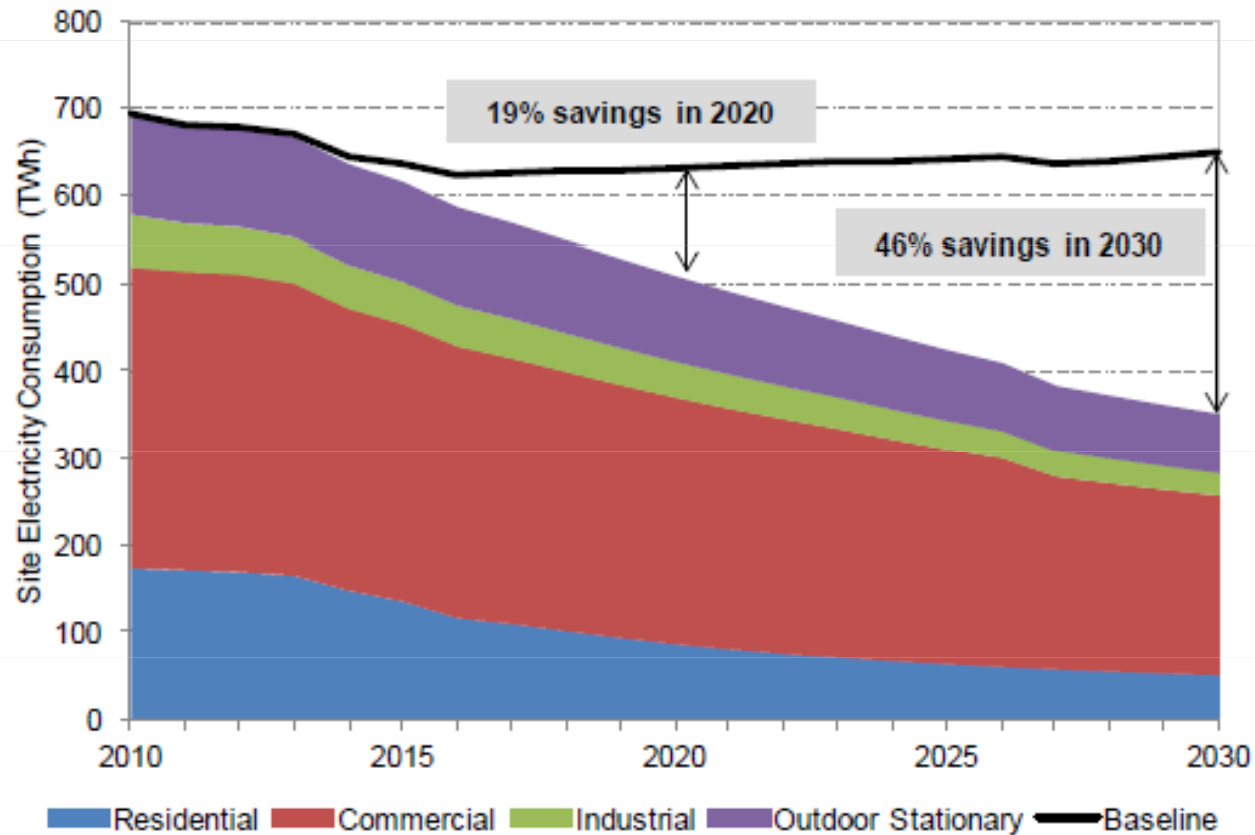
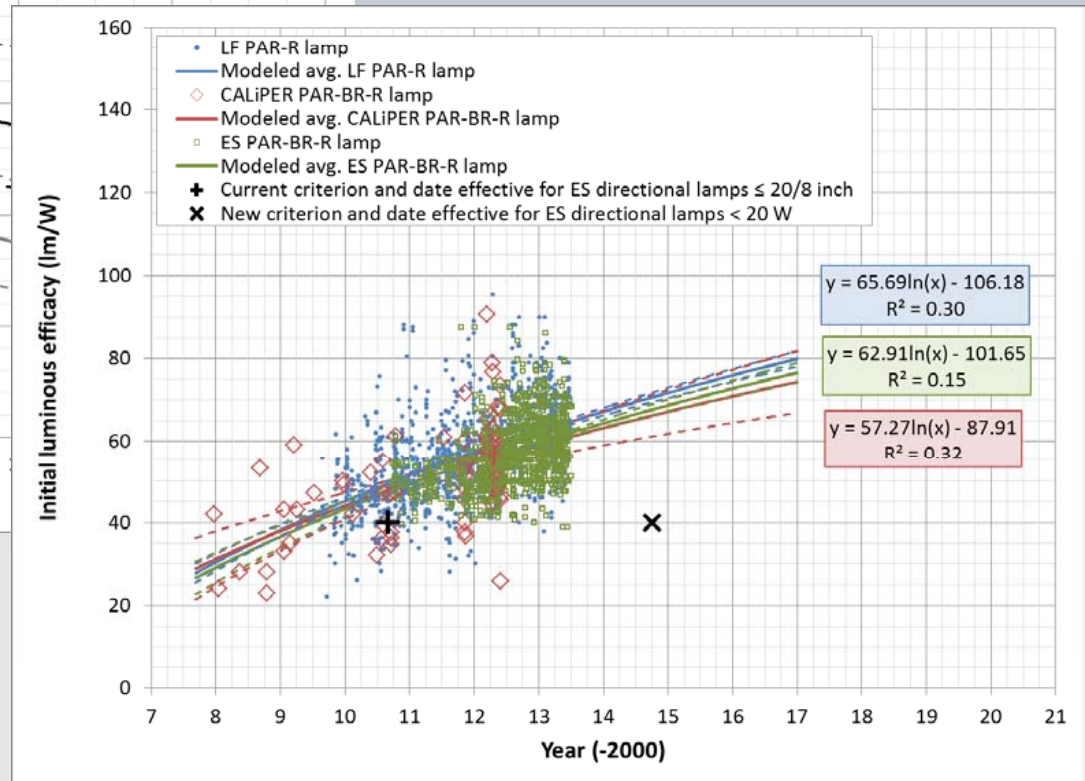
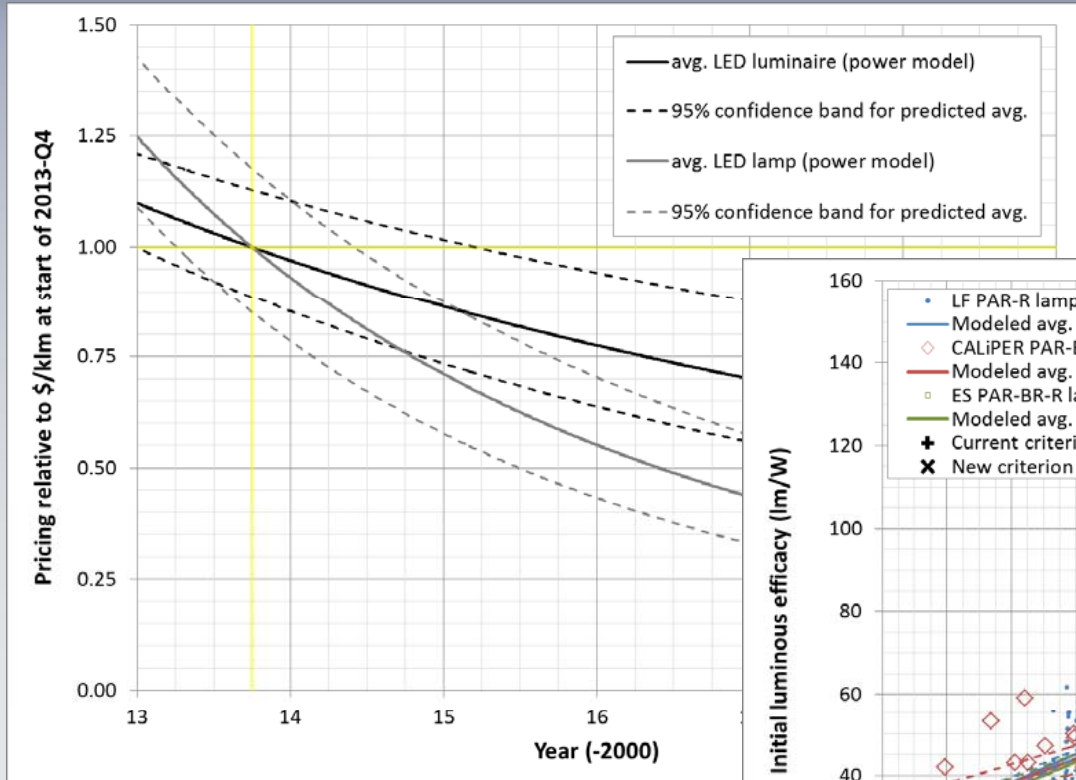


Figure 7.1 Total U.S. Lighting Energy Consumption Forecast, 2010 to 2030

Analysis of Pace of Trends



Typical Power Planning Assumptions

- **Baseline**
 - Federal standards or State codes **OR** better
- **Stock Turn-Over Rates**
 - Lamp burnout, fixture replacements & system remodels are relatively frequent in lighting
- **Frozen Efficiency Baseline**
 - Replaced lamps/fixtures are frozen at today's efficiency levels

Challenged by Fast-Paced SSL

Seventh Plan Issues

- Include forecast cost trends beyond 2015?
- Estimating pace of market uptake
- Near-term technology innovation
- Estimating old system turnover rates in face of new technology

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