

# Lighting Up the Night:

Performance Data and Economics from the  
Oakland Street Lighting Demonstration

E N E R G Y  S O L U T I O N S

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# PROJECT BACKGROUND



# Who Was Involved?

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- Pacific Gas & Electric Company
  - Emerging Technologies
- US Department of Energy
  - Solid State Lighting
- City of Oakland
  - Department of Public Works
  
- Monitoring Consultant: Energy Solutions



# Why LEDs?

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- Efficacy
- Directionality
- Lifespan/ Maintenance
- Light Quality



# Why outdoor lights / streetlights?

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- Long-term operation
  - Capitalize on maintenance savings
  - Longer paybacks may be acceptable
- Higher color temperatures are acceptable
  - Increased efficacy



# Demonstration Objectives

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- Primary objectives:
  - Determine product viability
  - Determine energy savings
- Secondary objectives:
  - Determine economic feasibility



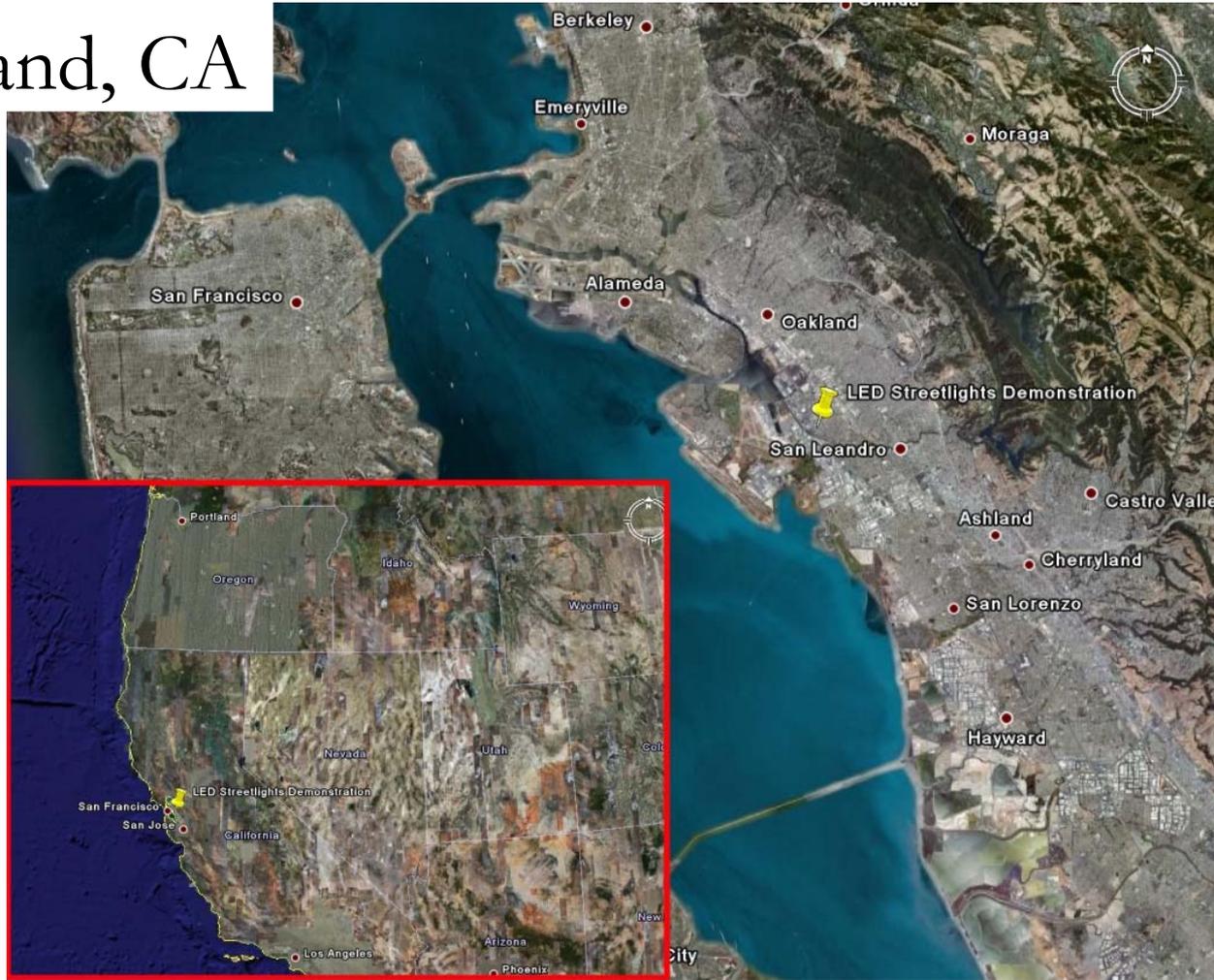
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# DEMONSTRATION



# Location

## Oakland, CA



# Technologies

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- Base Case
  - 100 Watt High Pressure Sodium (HPS) luminaire
- Replacement
  - Beta 'Edge' LED luminaire



# Parameters

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- 4 luminaires tested
  - 100 hours of operation prior to testing
- Luminaire spacing
  - 110', 120', 165'
- Luminaire height
  - 28'6"
- Grid spacing
  - 10' x 12', 12' x 12'



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# RESULTS



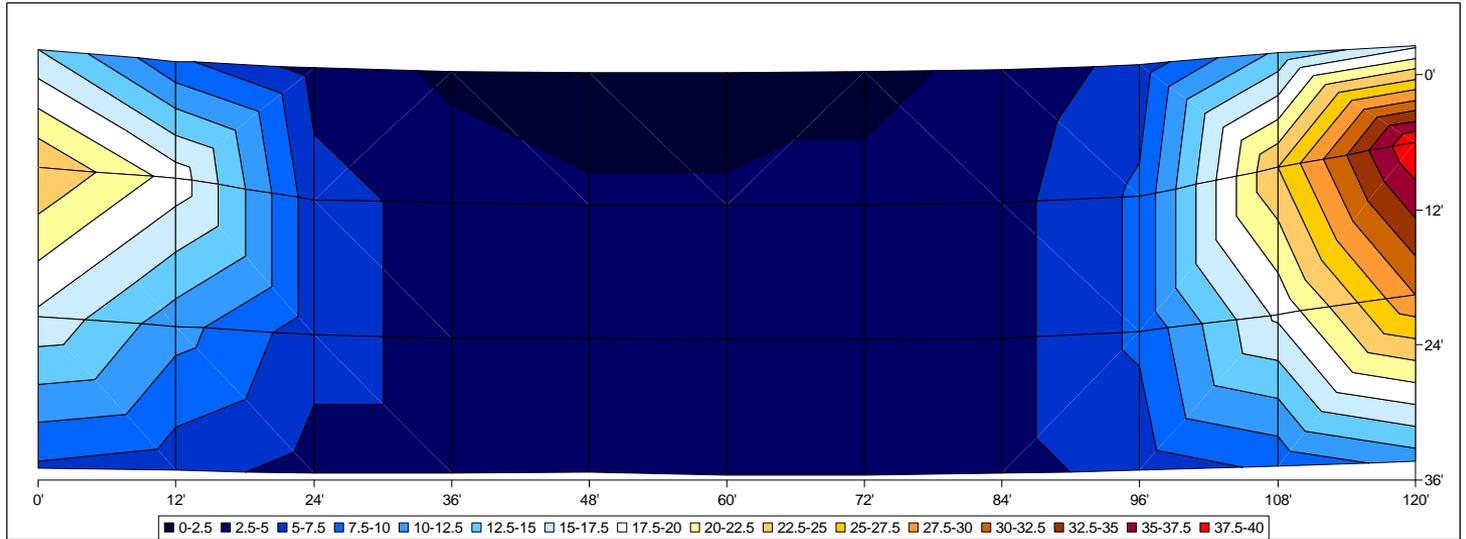
# Photopic Illuminance

## HPS

Avg: 0.80 fc

Uniformity:

40.00/1

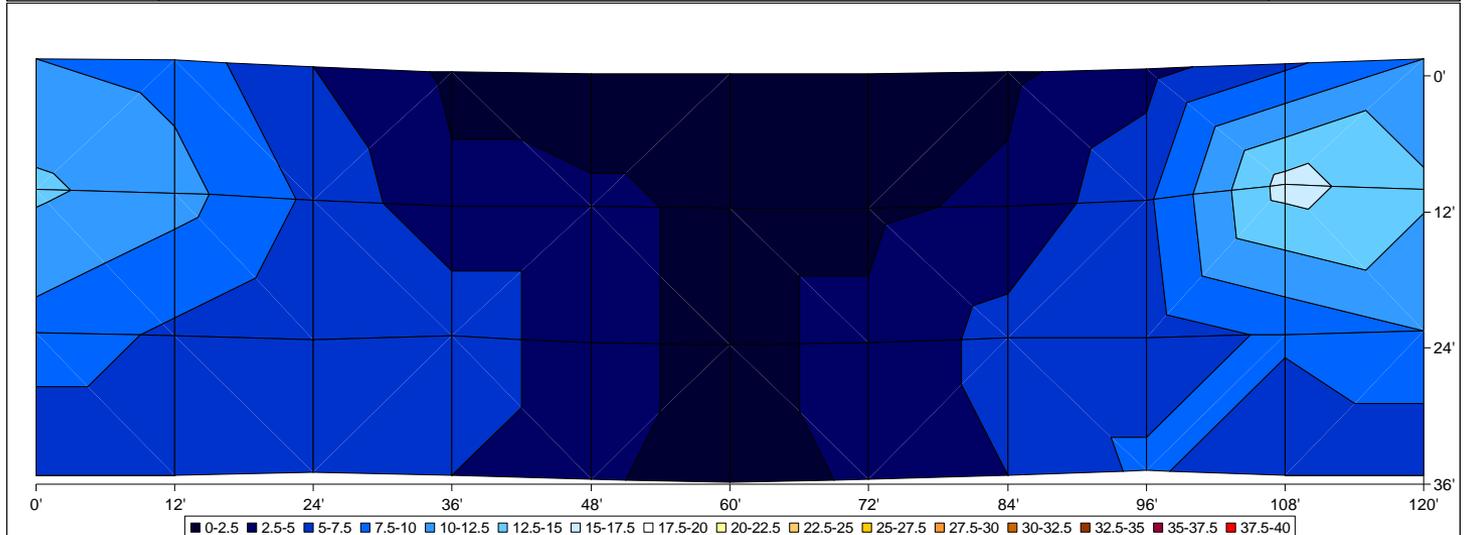


## LED

Avg: 0.53 fc

Uniformity:

16.00/1



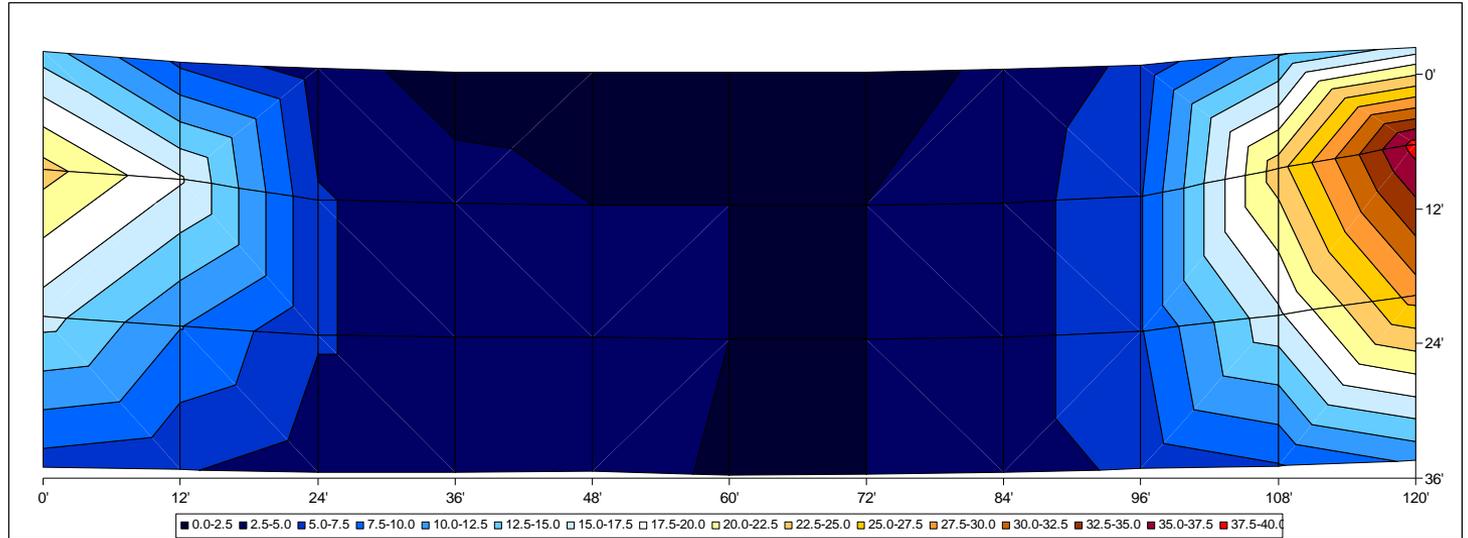
# Mesopic Illuminance (based on MOVE model)

## HPS

Avg: 0.74 fc

Uniformity:

38.48/1

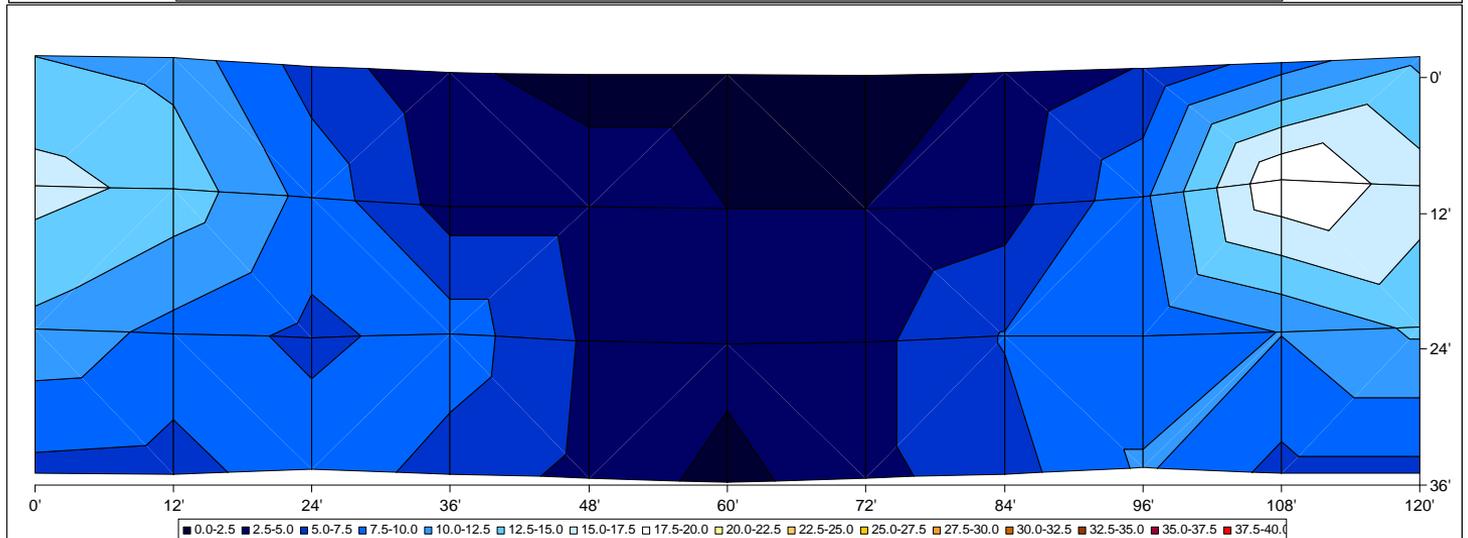


## LED

Avg: 0.68 fc

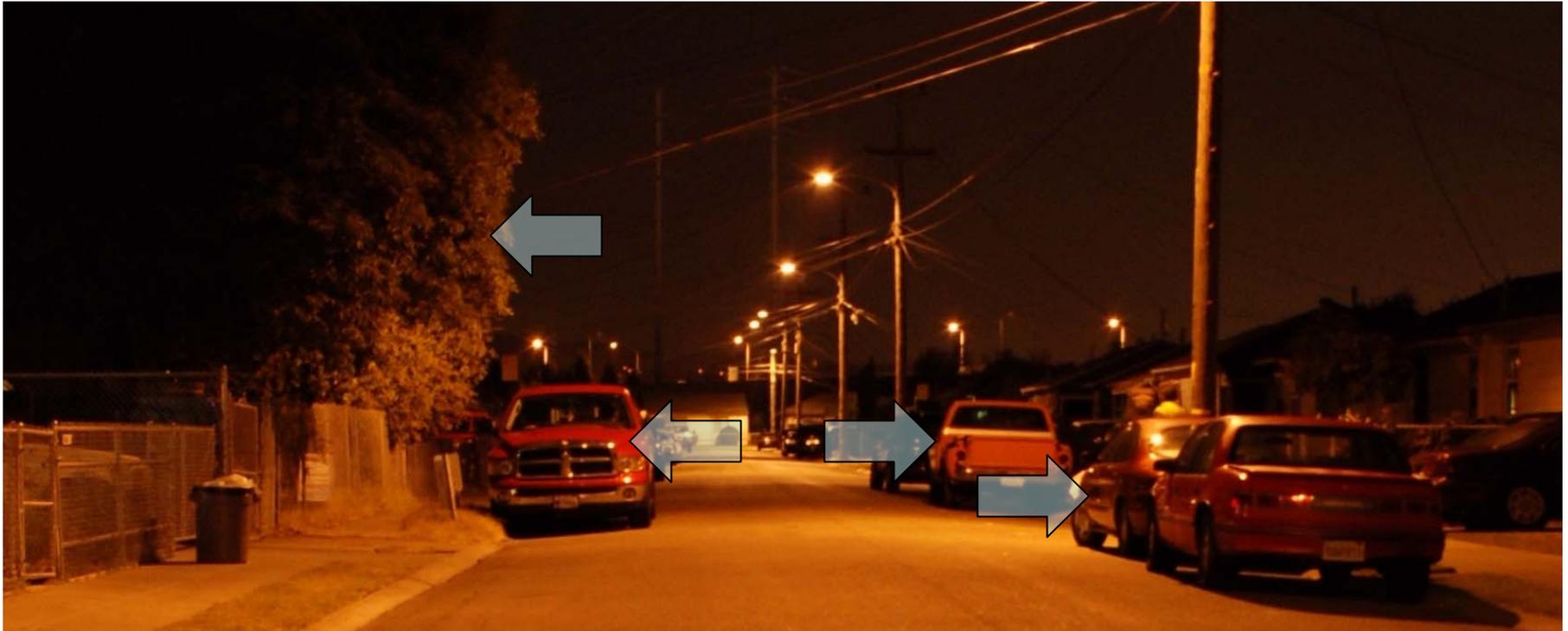
Uniformity:

19.88/1



# Color Temperature and Rendering

HPS



# Color Temperature and Rendering

## LED



# Color Temperature and Rendering

HPS



LED



# Survey Results

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- General luminaire preference
  - LED: 14 of 20 respondents
  - No Preference: 3 of 20
  - HPS: 3 of 20



# Survey Results

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- Better nighttime visibility
  - LED: 16 of 20 respondents
  - No difference: 4 of 20
  - HPS: 0 of 20



# Efficacy

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- HPS

- Estimated Source Efficacy
  - 78.51 lumens/watt (initial)
  - 70.25 lumens/watt (mean)
- Estimated Luminaire Efficacy
  - 66.74 lumens/watt (initial)
  - 59.71 lumens/watt (mean)

- LED

- Estimated Luminaire Efficacy
  - 57.5 lumens/watt (initial)
  - 48.88 lumens/watt (mean)



# Power

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- HPS
  - Power: 121.0 watts
  - Estimated Electricity: 496 kWh/ year
- LED
  - Power: 77.7 watts
  - Estimated Electricity: 319 kWh/ year
- Savings: 43.4 watts, 178 kWh/ year



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# ECONOMICS



# Main Economic Factors

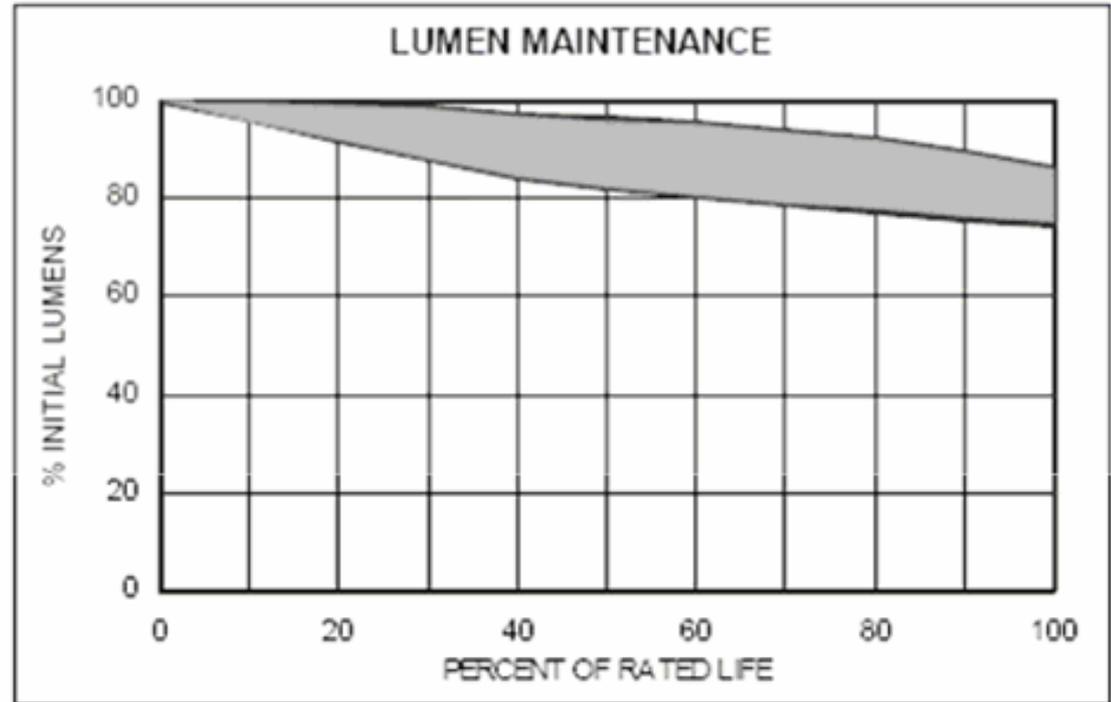
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- Energy Cost
- Maintenance Cost
- Upfront Cost (Initial Investment)



# Lifespan

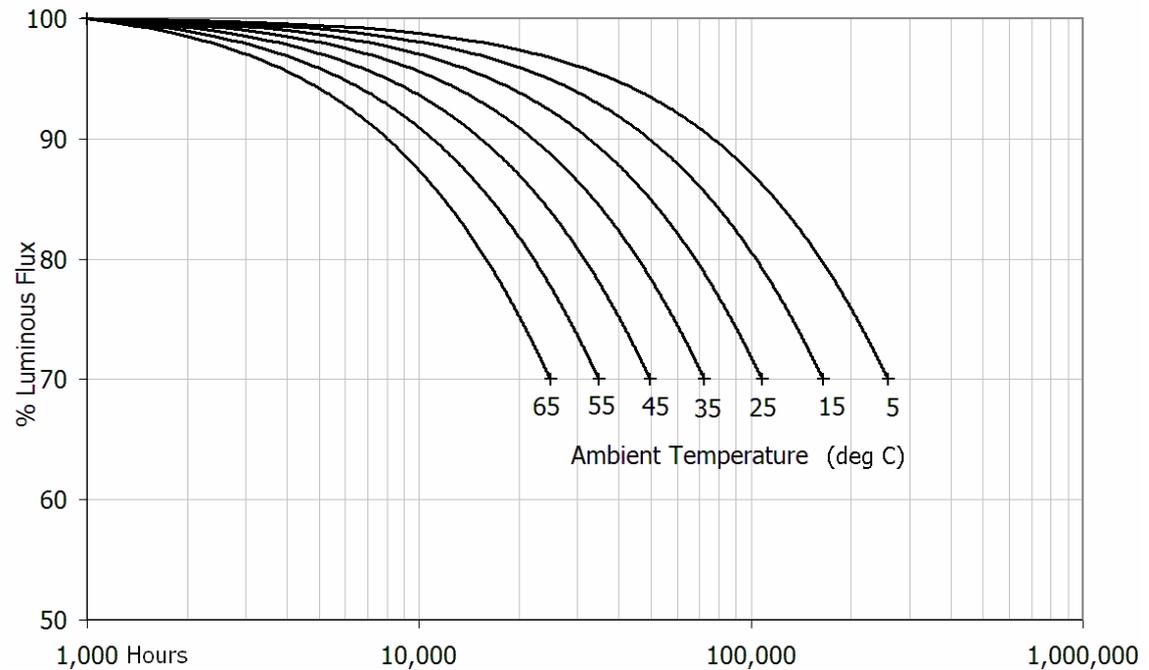
- HPS
  - Rated Life
    - 30,000 hours
    - (~ 7 years)
  - End of life lumen maintenance
    - ~ 80%



# Lifespan

## • LED

- Rated Life
  - >100,000 hours
  - (~24 years)\*
- End of life lumen maintenance
  - 70%
  - (by definition)



\* TESTING STANDARDS STILL UNDER DEVELOPMENT



# Annualized Costs

<b>Luminaire Type</b>	<b>Annual Maintenance Cost (per Luminaire)</b>	<b>Annual Energy Cost (per Luminaire)</b>	<b>Total Annual Cost (per Luminaire)</b>
<b>HPS (with Spot Replacement)</b>	\$20.40	\$63.95	\$84.34
<b>HPS (with Group Replacement)</b>	\$10.97	\$63.95	\$74.92
<b>LED</b>	\$0.00	\$42.21	\$42.21



# Payback

## ■ New Construction

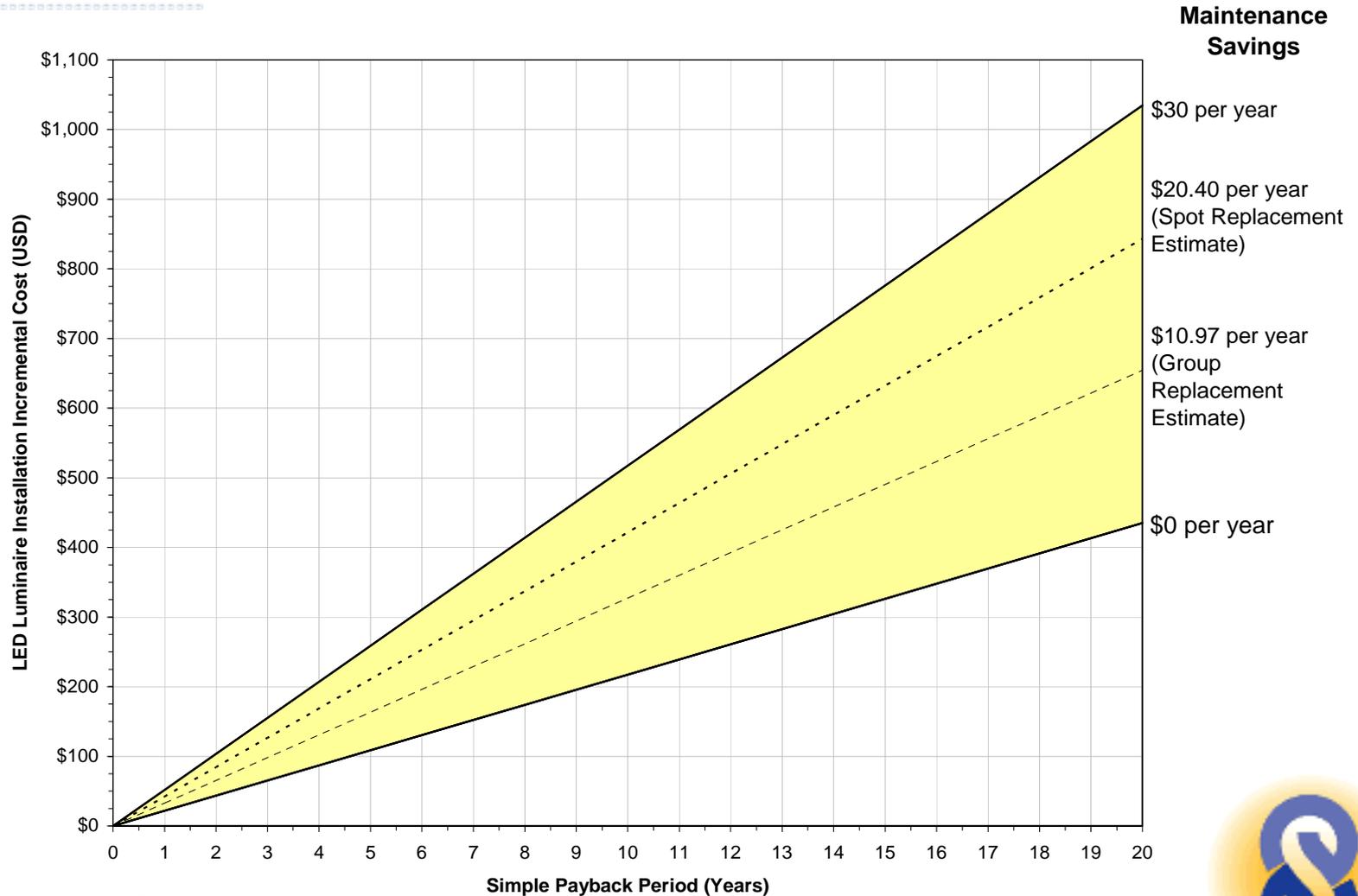
Luminaire Type	Initial Investment	Incremental Cost	Annual Savings	Simple Payback (Years)
HPS	\$346	--	--	--
LED (vs. HPS with Spot Replacement)	\$833	\$487	\$42	11.6
LED (vs. HPS with Group Replacement)	\$833	\$487	\$33	14.9

## ■ Retrofit

Luminaire Type	Initial Investment	Incremental Cost	Annual Savings	Simple Payback (Years)
HPS	\$0	--	--	--
LED (vs. HPS with Spot Replacement)	\$833	\$833	\$42	19.8
LED (vs. HPS with Group Replacement)	\$833	\$833	\$33	25.5



# Situational Sensitivity



# Summary

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- LEDs were a viable alternative for 100 watt HPS fixtures
- LEDs offered greater perceived visibility (despite reduced average illumination)
- Estimated 44 – 50% annual cost savings from LEDs in test scenario
- High upfront costs can lead to long simple paybacks
- Simple paybacks sensitive to estimated maintenance savings (up to 1/2 of total estimated savings)



# For more information

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Full Report Available At:

<http://www.netl.doe.gov/ssl/techdemos.htm>

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