

# Saving Energy and Improving Light Quality in Street Lighting

## Applications of the *SEAD Street Lighting Tool*

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CLASP

# AGENDA

- About SEAD and the Tool
- Tool Features
- Future of the Tool

# SUPER-EFFICIENT EQUIPMENT AND APPLIANCE DEPLOYMENT (SEAD) INITIATIVE

SEAD engages governments and the private sector to accelerate market transformation for energy-efficient equipment and appliances

## 16 Participating Governments

- Australia
- France
- Korea
- Sweden
- United States
- Brazil
- Germany
- Mexico
- United Arab Emirates
- *China (observer)*
- Canada
- India
- Russia
- United Kingdom
- European Commission
- Japan
- South Africa

## Partners



# Why Make a Tool for Street Lighting?

**Problem:** With new fixture choices, wattage and light distribution classifications have less correlation with fixture performance on a specific road. Improved performance and energy savings depend on proper fixture selection.

**Solution:** Simplified photometric analysis, integrated with energy and life cycle cost considerations, can allow lighting specifiers to find better fixtures for their lighting upgrades.

# What is the SEAD Street Lighting Tool?

The **SEAD Street Lighting Tool**, is a new, free software tool for analyzing fixture choices for street and roadway lighting that analyzes energy use, light quality, and lifecycle costs.

## *The tool can be used for:*

- a) Batch calculations of dozens to hundreds of fixtures at once; distinct advantage in retrofit scenarios
- b) Streamlined analysis for initial road configurations/lighting in early stages of the design process
- c) An introduction to photometric analysis for novice users

Download the tool at [www.superefficient.org](http://www.superefficient.org)

# Tool Features

## *Core Purpose:*

**Integrating a photometric analysis of a batch of fixtures with an analysis of energy consumption and life cycle cost**

# Overview

## *Tool Summary*

- Excel tool, compatible with 2003 and later
- Available in English, French and Spanish
  - Can support additional languages if partners can help with translation
- Available from: <http://superefficient.org/sltool>

# Road Configuration Options

- **Lane options:**

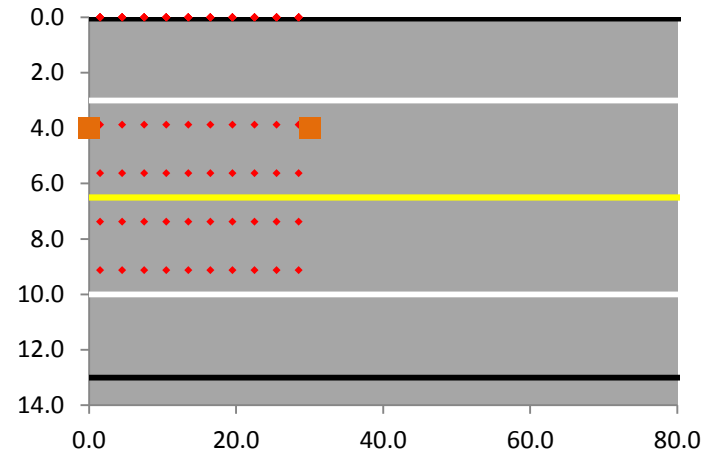
- Two, four and six lane roads with or without medians
- User specified lane width

- **Pole configurations:**

- Single-side, Staggered, Median-mounted

- **User specified spacing and sizing:**

- Pole height
- Pole spacing
- Arm length



Description: Baseline	
<b>Road Geometry</b>	
Number of Lanes	2
Lane Width	3.5
Shoulder Width	3
Median Width	0
<b>Light Geometry:</b>	
Pole Placement	Staggered
Pole Height	9
Pole Spacing	45
Pole Setback	3
Arm length	4
Number of Points in Grid	10
Spacing of Grid	4.50
Fixtures/km	22





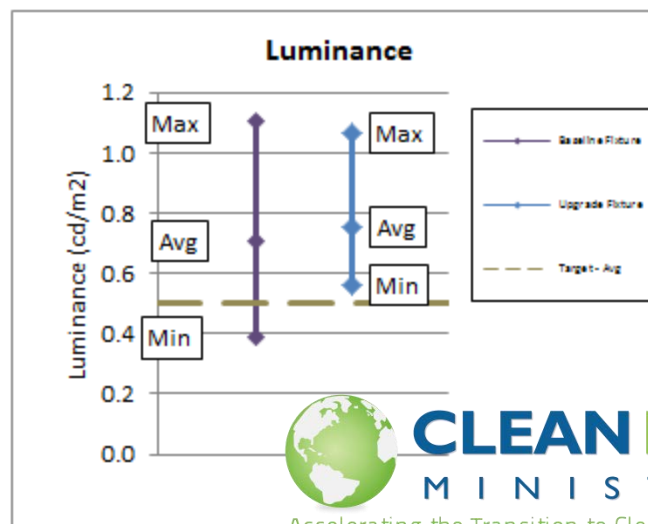
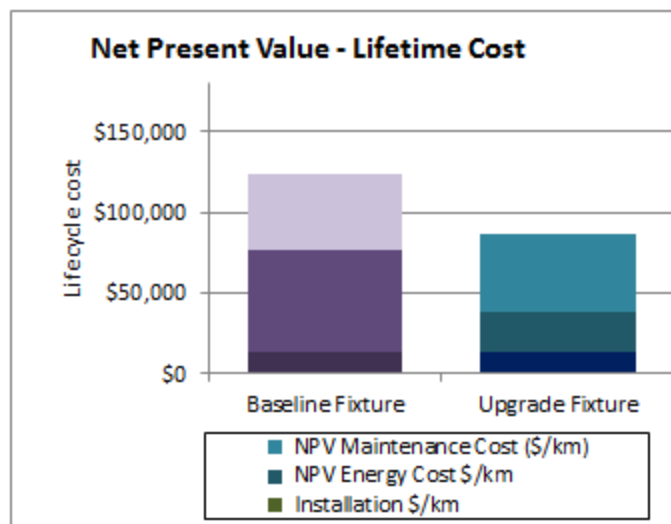
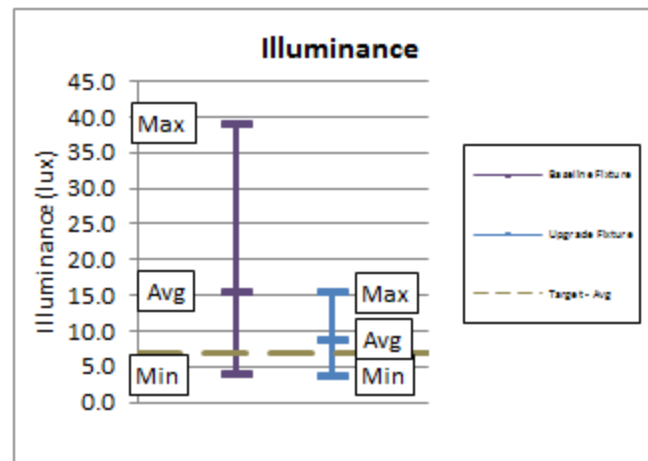
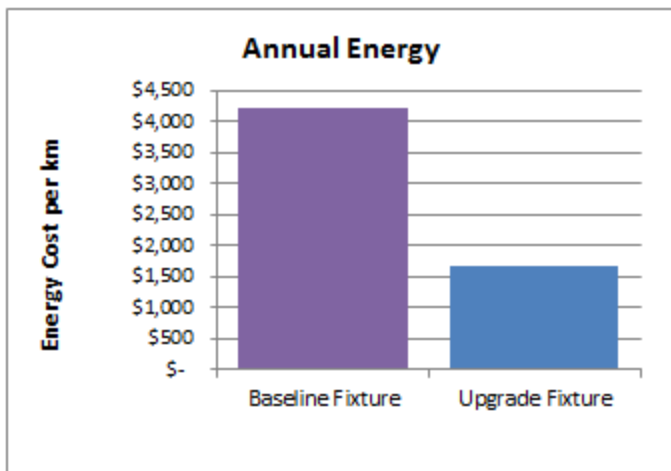
# Fixture Choices & Calculations

## *Fixture Calculations:*

- Luminance and illuminance calculations using IES methodology
- Graphical results indicate which fixtures meet your light level and uniformity targets
- Energy and costs reported in a variety of methods:
  - kWh/kilometer/year
  - kWh/fixture/year
  - \$/kilometer/year
  - NPV of lifecycle installation, energy, and maintenance costs

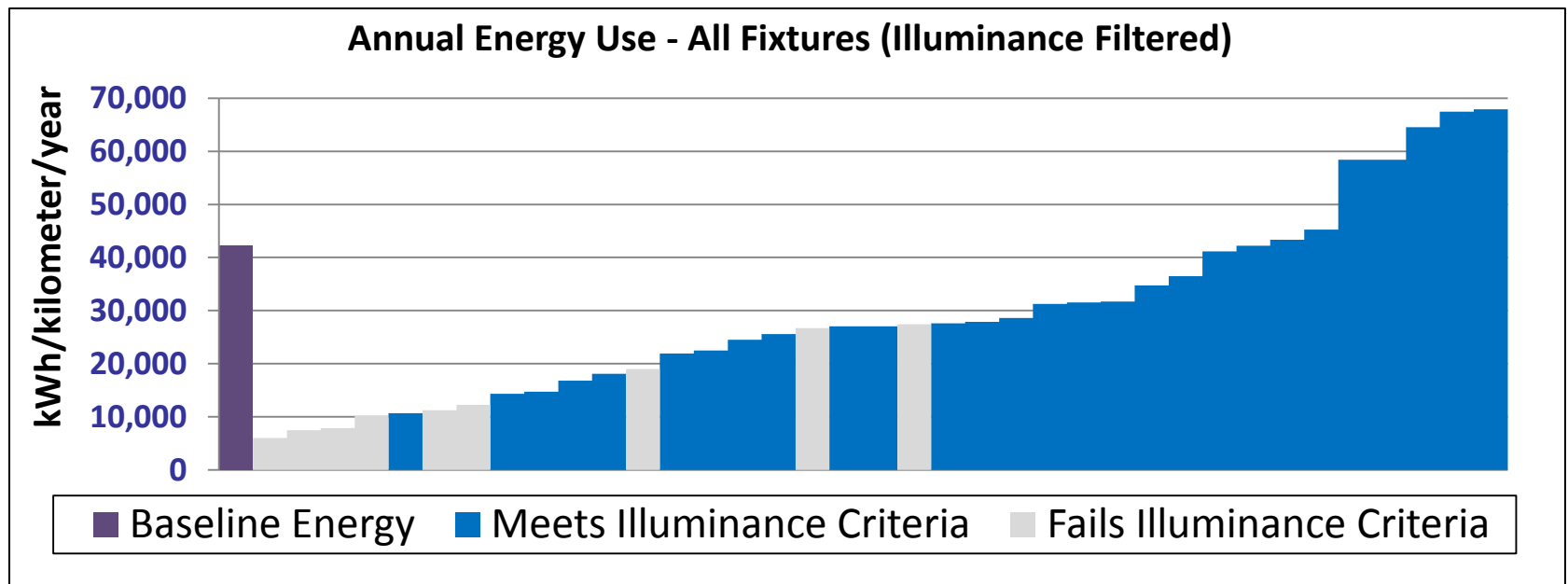
# Analysis Methods

- Quick Comparison of a single fixture to a baseline



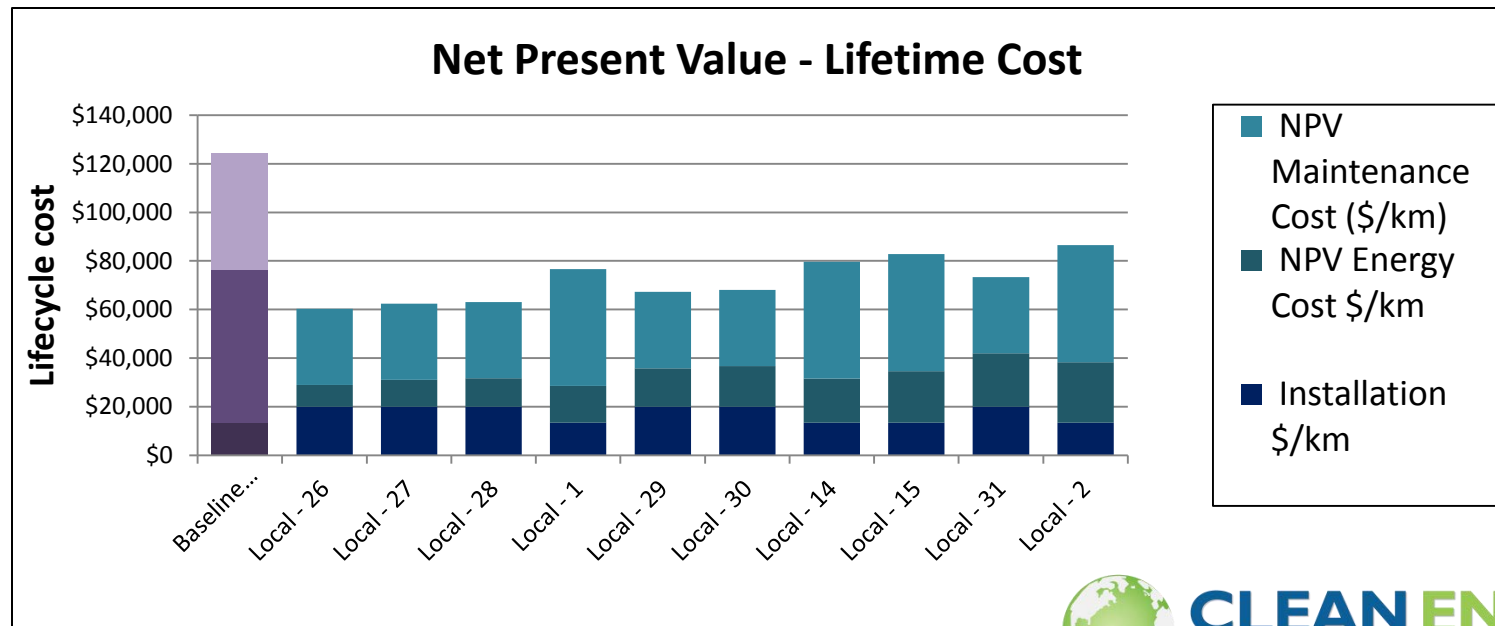
# Analysis Methods

- Batch method to simulate up to hundreds of fixtures for a given layout at once
- Multiple batches and single runs can be saved and compared
- Quick assessment of functionality with three example analyses



# Basic Financial Analysis

- Projects level inputs for fixture installation labor, pole installation and bulb replacement cost
- Fixture-specific inputs for fixture costs and expected life
- Life cycle cost analysis



# Future of the Tool

# Tool Implementation Plan

## Tool Implementation Partnerships

- Feedback on tool utility and features
- Assurance to future users of tool capabilities

## Tool Upgrades

- Improved usability
- Improved financial analysis
- CIE calculations

## Tool Dissemination

- Informing potential users of the tool
- Improved training and documentation

## Additional Street Lighting Projects

- Identification of other key barriers to SL installations
- Considering additional projects to address barriers



# Tool Implementation Partnerships

- First location is with LightSavers Canada (January 2012)
- Seeking additional locations

## **Benefits:**

- Training on tool
- Assistance in analysis
- Case study report

## **Partner Needs:**

- Initial planning stage
- Feedback on tool usability
- Time available for conducting analysis

*Summary of implementation pilot concept on tool website, or by emailing [sltoolkit@superefficient.org](mailto:sltoolkit@superefficient.org)*



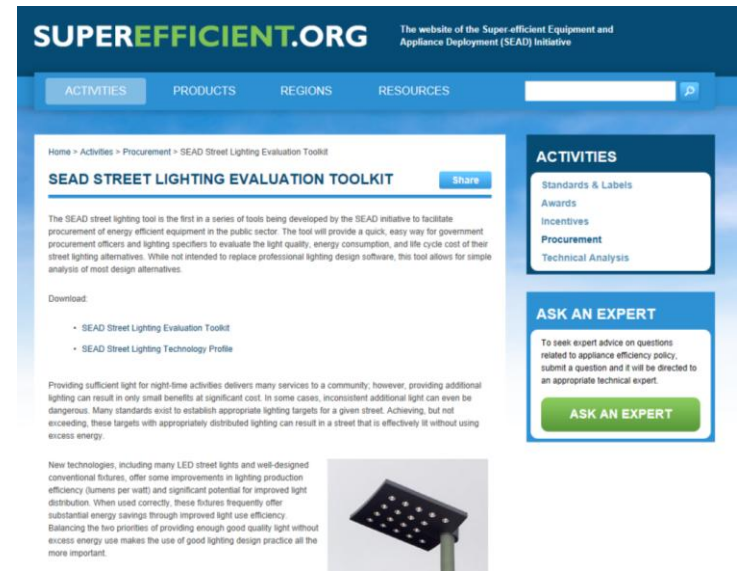
**Discussion and Questions**  
[sltoolkit@superefficient.org](mailto:sltoolkit@superefficient.org)

# Using the Tool

(tool screenshots if needed for questions)

# Getting Started

- **Excel based, free to download and distribute**
  - Available from SEAD website, [www.superefficient.org](http://www.superefficient.org)
- **Uses macros, which must be enabled**
- **Tool is a series of worksheets, navigable by the tabs or links located on each sheet**
- **On download, no entries in input field or results saved**
  - For a quick start to explore the tool's functionality, three examples are available



# Doing an Analysis

- Analysis steps revolve around the “Input” worksheet
- Input cells are yellow, calculated cells are blue



## SEAD Street Lighting Tool v1.0.4

Select Language:

English

### SEAD Procurement Tool for Energy Efficient Street Lighting

This calculator was designed to help purchasers of street lighting fixtures better understand the energy consumption and lighting performance of both traditional and emerging energy efficient street lighting products. While not intended to replace professional lighting design software, it does provide analysis to compare the lighting quality and energy use of multiple fixtures.

Before you get started, please take some time to read the instructions located on the navigation worksheet .



Next

Have comments or feedback? Send an email to [s toolkit@superefficient.org](mailto:s toolkit@superefficient.org)  
This tool and accompanying street lighting technology profile are available at [www.superefficient.org](http://www.superefficient.org)



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# Step 1: Road Geometry

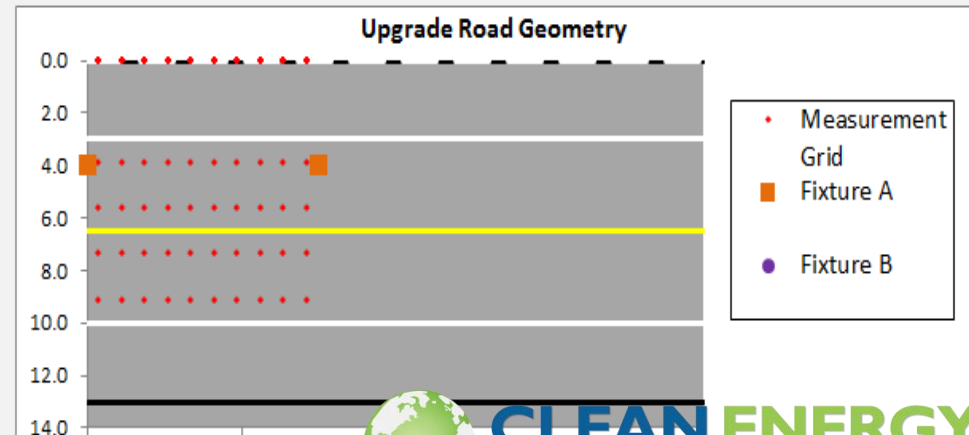
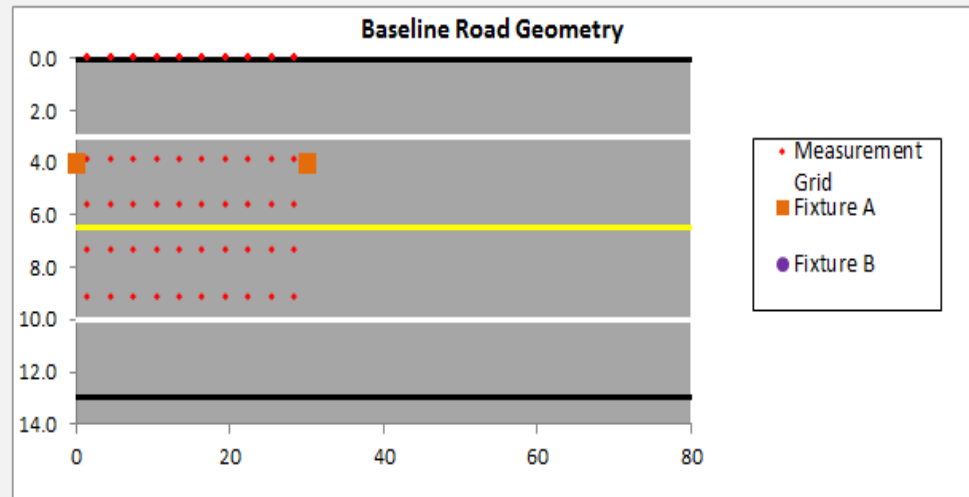
Back to Inputs

Change these inputs to describe your road configuration

Description:	Baseline	Upgrade	Units
<b>Road Geometry</b>			
Number of Lanes	2	2	lanes
Lane Width	3.5	3.5	meters
Shoulder Width	3	3	meters
Median Width	0	0	meters

<b>Light Geometry:</b>			
Pole Placement	Single-side	Single-side	
Pole Height	9	9	meters
Pole Spacing	30	30	meters
Pole Setback	3	3	meters
Arm length	4	4	meters

Number of Points in Grid	10	10	
Spacing of Grid	3.00	3.00	meters
Fixtures/km	33	33	



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# Step 2: Light Levels

← Back to Inputs

### Illuminance Method

Average Illuminance Target (Iavg)	7	Lux
Uniformity Ratio (Eavg/Emin)	6	unitless

### Luminance Method

Road Surface Type	R3	Standard Surface
Average Luminance Target (Lav)	0.5	cd/m2
Overall Uniformity (U0 - avg/min)	6	unitless

Note CIE U0 is the inverse of IES U0; value should be IES method, greater than one

### View Description of a Standard Below:

Add a Standard    Save New Standard

Have a standard that should be added to the tool? Send

There are many standards that define appropriate lighting levels for appropriate lighting levels for roadways. The two international standards are the International Engineering Society of North America (IESNA) RP-8:2005 standard and the International Commission on Illumination (CIE) CIE 115:2010 standard. Other national organizations, national governments and municipalities define similar standards.

In calculating light quality, this tool supports the illuminance and luminance calculation methods as defined by IESNA. Many competing standards use the same calculation methodology but prescribe different lighting levels, while others may use different calculation methods.

Currently, the CIE method of calculation is not supported. Although the two methods are similar, they use different assumptions as to observer location, measurement grid locations, etc. Although IESNA calculations will provide different results, they should still provide good first-order information about how different fixture options compare to each other.

To use this tool, simply enter the target luminance or illuminance values. Guidance on how to determine these target levels for your specific road is shown below by selecting the appropriate standard from the drop down menu. Users can also save information on other standards for future reference by using the scratch space provided when you select the "Add Standard" option.

If you would like to exceed the target, simply increase the input value on the



# Step 3: Select Fixtures

### Select Baseline

Choose Baseline Fixture

- I - HPS 150W Type IV Very Short
- J - HPS 250W Type III
- K - HPS 250W Type III
- L - HPS 400W Type III
- M - HPS 400W Type III Med
- N - MH 70W MH
- O - MH 90W Type II Short

Fixture Name	I - HPS 150W Type IV Very Short
Type	0 ?
Watts	289 ?
Lamp Lumen Depreciation	0.73 ?
Total Light Loss Factor	0.64 ?
Ballast Factor	1.00 ?

### Choose Upgrade Option - Single Scenario or Multiple Fixtures

#### Choose Single Upgrade Fixture

- <No Fixture>
- A - HPS 70W Type II
- B - HPS 100W Type II Short
- C - HPS 100W Type III Med
- D - HPS 150W Type II
- E - HPS 150W Type IV
- F - HPS 150W Type IV

B - HPS 100W Type II Short
0 ?
115 ?
0.73 ?
0.64 ?
1.00 ?

-  
OR  
-

#### Analyze Multiple Fixture Options

Select Multiple Fixtures

*Add IES file*

Click this button to choose the file path of a new IES file to add to the fixture list

*Add Multiple IES Files*

*Delete Fixture Data*

### Optional Assumptions

Luminaire Dirt Depreciation	0.88	Default 0.88 assumes clean environment at 8 years
Temperature Effects	1	Default 1 indicates no temperature effects include
Operating hours	4380	Default 4380 assumes 12 hours per day



# Step 3: Select Fixtures

Include	Fixture Name	Fixture Data Row	Manufacturer	Type	Model #	Watts	Distribution Type	Comments
	<No Fixture>	#N/A	No fixture	HPS		0	0	0
1	x A - HPS 70W Type II	1	Generic	HPS	NA	70		
35	x B - HPS 100W Type II Short	35	Generic	HPS	NA	115	TYPE II, SHORT, FULL CUTOFF	
118	C - HPS 100W Type III Med	118	Generic	HPS	NA	130	TYPE III, MEDIUM, CUTOFF	
201	D - HPS 150W Type II	201	Generic	HPS	NA	189	TYPE II, MEDIUM, FULL CUTOFF	
284	E - HPS 150W Type IV	284	Generic	HPS	NA	150		
284	F - HPS 150W Type IV	316	Generic	HPS	NA	183	MS4	
362	G - HPS 150W Type IV Long	362	Generic	HPS	NA	188	TYPE IV, LONG, NONCUTOFF	
402	H - HPS 150W Type IV Very Short	402	Generic	HPS	NA	310	TYPE IV, VERY SHORT, FULL CUTOFF	
402	I - HPS 150W Type IV Very Short	485	Generic	HPS	NA	289	TYPE IV, VERY SHORT, FULL CUTOFF	
525	J - HPS 250W Type III	525	Generic	HPS	NA	250		
525	K - HPS 250W Type III	559	Generic	HPS	NA	297	TYPE III, MEDIUM, FULL CUTOFF	
591	L - HPS 400W Type III	591	Generic	HPS	NA	400		
623	M - HPS 400W Type III Med	623	Generic	HPS	NA	465	TYPE III, MEDIUM, CUTOFF	
706	N - MH 70W MH	706	Generic	MH	NA	84		
735	O - MH 90W Type II Short	735	Generic	MH	NA	98	TYPE II, SHORT, FULL CUTOFF	
775	P - MH 140W Type II Short	775	Generic	MH	NA	154	TYPE II, SHORT, SEMICUTOFF	
815	Q - MH 150W MH	815	Generic	MH	NA	168		
284	R - MH 150W Type IV	844	Generic	MH	NA	185		
284	S - MH 150W Type IV	876	Generic	MH	NA	185		
402	T - MH 150W Type IV Very Short	908	Generic	MH	NA	282	TYPE IV, VERY SHORT, FULL CUTOFF	
948	U - MH 175W Type II Short	948	Generic	MH	NA	214	TYPE II, SHORT, FULL CUTOFF	
1031	V - MH 175W Type IV	1031	Generic	MH	NA	175		





# Step 3: Select Fixtures

1 2 3 4 5 6 7 8 9

Manufacturer	Type	Model #	Watts	Distribution Type	Comments	Fixture Cost (material)	Fixture Life (hours)	Replacement Bulb Cost (material)	Lamp Lumen Depreciation	Ballast Factor
No fixture	HPS		0			\$0	#####	\$ -	-	1.00
Generic	HPS	NA	70			\$300	20,000	\$ 160	0.73	1.00
Generic	HPS	NA	115	TYPE II, SHORT, FULL CUTOFF		\$300	20,000	\$ 160	0.73	1.00
Generic	HPS	NA	130	TYPE III, MEDIUM, CUTOFF		\$300	20,000	\$ 160	0.73	1.00
Generic	HPS	NA	189	TYPE II, MEDIUM, FULL CUTOFF		\$300	20,000	\$ 160	0.73	1.00
Generic	HPS	NA	150			\$300	20,000	\$ 160	0.73	1.00
Generic	HPS	NA	183	MS4		\$300	20,000	\$ 160	0.73	1.00
Generic	HPS	NA	188	TYPE IV, LONG, NONCUTOFF		\$300	20,000	\$ 160	0.73	1.00
Generic	HPS	NA	310	TYPE IV, VERY SHORT, FULL CUTOFF		\$300	20,000	\$ 160	0.73	1.00
Generic	HPS	NA	289	TYPE IV, VERY SHORT, FULL CUTOFF		\$300	20,000	\$ 160	0.73	1.00
Generic	HPS	NA	250			\$300	20,000	\$ 160	0.73	1.00
Generic	HPS	NA	297	TYPE III, MEDIUM, FULL CUTOFF		\$300	20,000	\$ 160	0.73	1.00
Generic	HPS	NA	400			\$300	20,000	\$ 160	0.73	1.00
Generic	HPS	NA	465	TYPE III, MEDIUM, CUTOFF		\$300	20,000	\$ 160	0.73	1.00
Generic	MH	NA	84			\$300	20,000	\$ 160	0.73	1.00
Generic	MH	NA	98	TYPE II, SHORT, FULL CUTOFF		\$300	20,000	\$ 160	0.73	1.00
Generic	MH	NA	154	TYPE II, SHORT, SEMICUTOFF		\$300	20,000	\$ 160	0.73	1.00
Generic	MH	NA	168			\$300	20,000	\$ 160	0.73	1.00
Generic	MH	NA	185			\$300	20,000	\$ 160	0.73	1.00
Generic	MH	NA	185			\$300	20,000	\$ 160	0.73	1.00
Generic	MH	NA	282	TYPE IV, VERY SHORT, FULL CUTOFF		\$300	20,000	\$ 160	0.73	1.00
Generic	MH	NA	214	TYPE II, SHORT, CUTOFF		\$300	20,000	\$ 160	0.73	1.00
Generic	MH	NA	175			\$300	20,000	\$ 160	0.73	1.00



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# Step 4: Cost Information

## Step 4. Enter Cost Information

Enter your relevant costs, paying particular attention to 'labor' vs. 'materials.' Note that some costs are fixture specific, and are located on the fixture tab - defaults are provided, but should be checked for your location. If you use a currency other than dollars, simply change all the relevant prices to proper estimates in your currency, changing the cell formatting if desired.

General Costs	Baseline
Fixture installation (labor)	\$100.00
Pole installation cost (labor + materials)	\$0.00
Bulb Replacement Cost (labor only)	\$300.00

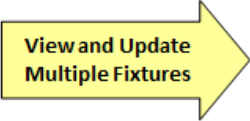
Upgrade
\$100.00
\$0.00
\$300.00

Energy Cost (\$/kWh)	\$0.10
Discount Rate	3%
Analysis Period (years)	20

	Baseline Fixture	
Fixture Cost	\$300	?
Fixture Life (hours)	20,000	?
Replacement Bulb Cost	\$160	?

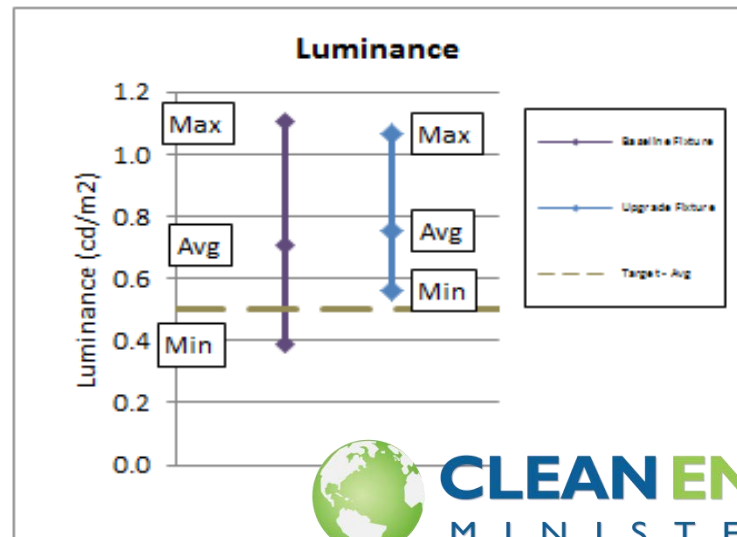
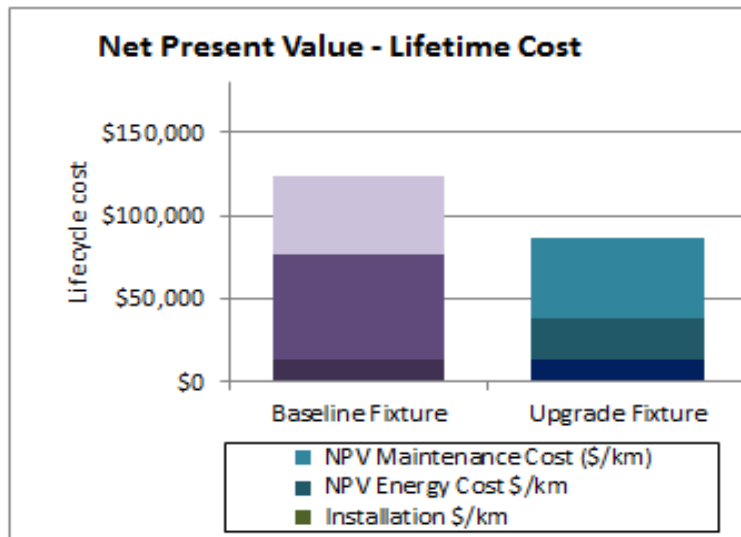
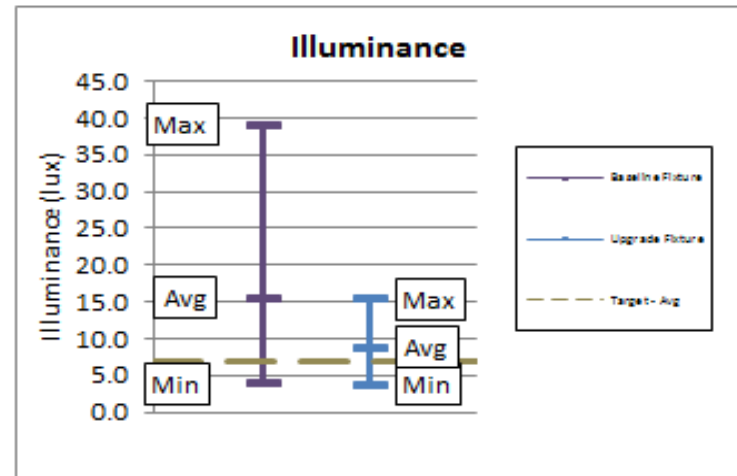
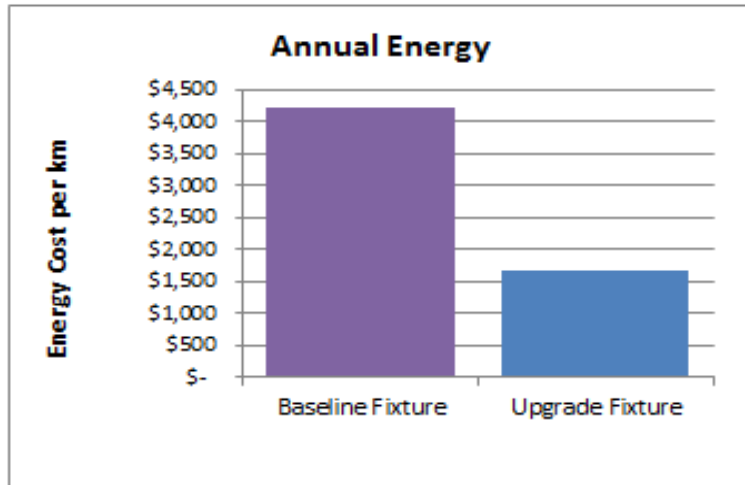
	Upgrade fixture	
Fixture Cost	\$300	?
Fixture Life (hours)	20,000	?
Replacement Bulb Cost	\$160	?

**Analyze Multiple Fixture Costs**



**View and Update Multiple Fixtures**

# Single Fixture Comparison



# Measurement Grid Results

## Illuminance values for measurement grid

Units = Lux

### Baseline

Distance from Origin	1.5	4.5	7.5	10.5	13.5	16.5	19.5	22.5	25.5	28.5	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.9	14.0	8.9	6.2	4.5	4.0	4.0	4.5	6.2	8.9	14.0									
5.6	38.5	22.5	13.4	7.9	6.1	6.1	7.9	13.4	22.5	38.5									
7.4	35.9	24.1	15.4	8.5	6.6	6.6	8.5	15.4	24.1	35.9									
9.1	39.2	25.2	16.1	9.7	6.7	6.7	9.7	16.1	25.2	39.2									

### Upgrade

Distance from Origin	1.5	4.5	7.5	10.5	13.5	16.5	19.5	22.5	25.5	28.5	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.9	14.0	8.9	6.2	4.5	4.0	4.0	4.5	6.2	8.9	14.0									
5.6	38.5	22.5	13.4	7.9	6.1	6.1	7.9	13.4	22.5	38.5									
7.4	35.9	24.1	15.4	8.5	6.6	6.6	8.5	15.4	24.1	35.9									
9.1	39.2	25.2	16.1	9.7	6.7	6.7	9.7	16.1	25.2	39.2									

## Luminance values for measurement grid

Units = cd/m2

### Baseline

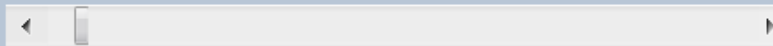
Distance from Origin	1.5	4.5	7.5	10.5	13.5	16.5	19.5	22.5	25.5	28.5	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.9	1.1	0.9	0.8	0.9	0.8	0.8	0.8	0.8	0.9	0.8									
5.6	0.9	0.8	0.8	0.9	0.9	0.9	0.9	0.8	0.7	0.7									
7.4	0.6	0.6	0.6	0.7	0.8	0.8	0.7	0.6	0.5	0.5									
9.1	0.5	0.5	0.5	0.6	0.6	0.7	0.6	0.5	0.4	0.4									



# Batch Analysis Results

## RESULTS

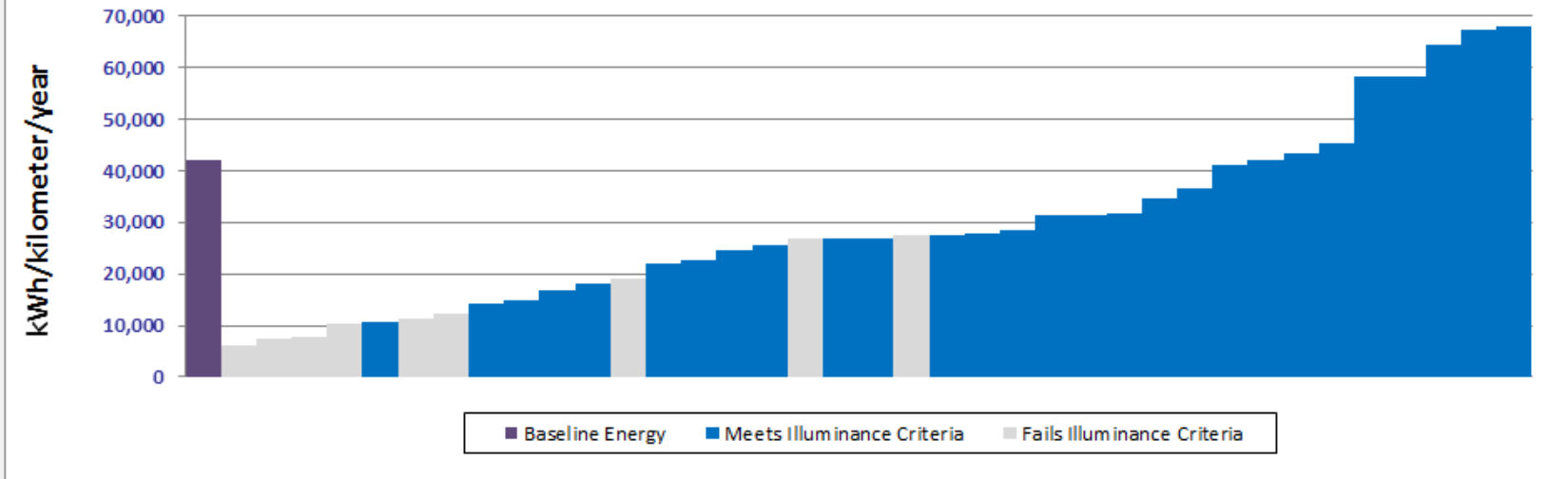
Scroll to see more results --->



See tabular

All fixtures included on the 'Mresults' tab are included in this graph

### Annual Energy Use - All Fixtures



In the rest of the graphs below, only ten fixtures at a time are included. Use the scrollbar at the top to see all the results

Scenario	Fixture Name	Type	Watts	Number of Lanes	Lane Width	Pole Placement	Pole Height	Pole Spacing
Introduction	Examples	Inputs	Road Geometry	Lighting Standards	Fixtures	SReport	SReportGrid	



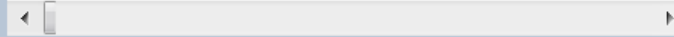
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# Batch Analysis Results

## RESULTS

Scroll to see more results --->



See tabular

In the rest of the graphs below, only ten fixtures at a time are included. Use the scroll bar at the top to see all the results

Scenario	Fixture Name	Type	Watts	Number of Lanes	Lane Width	Pole Placement	Pole Height	Pole Spacing
Baseline	I - HPS 150W Type IV Very Short	0	289	2	3.5	Single-side	9	30
Local - 26	AF - LED 41W Type III	0.0	41.0	2.0	3.5	Single-side	9.0	30.0
Local - 27	AG - LED 51W Type III	0.0	51.0	2.0	3.5	Single-side	9.0	30.0
Local - 28	AJ - LED 54W Type III	0.0	54.0	2.0	3.5	Single-side	9.0	30.0
Local - 1	A - HPS 70W Type II	0.0	70.0	2.0	3.5	Single-side	9.0	30.0
Local - 29	AH - LED 73W Type III	0.0	73.0	2.0	3.5	Single-side	9.0	30.0
Local - 30	AK - LED 77W Type III	0.0	77.0	2.0	3.5	Single-side	9.0	30.0
Local - 14	N - MH 70W MH	0.0	84.0	2.0	3.5	Single-side	9.0	30.0
Local - 15	O - MH 90W Type II Short	0.0	98.0	2.0	3.5	Single-side	9.0	30.0
Local - 31	AI - LED 101W Type III	0.0	101.0	2.0	3.5	Single-side	9.0	30.0
Local - 2	B - HPS 100W Type II Short	0.0	115.0	2.0	3.5	Single-side	9.0	30.0

Sort by Energy

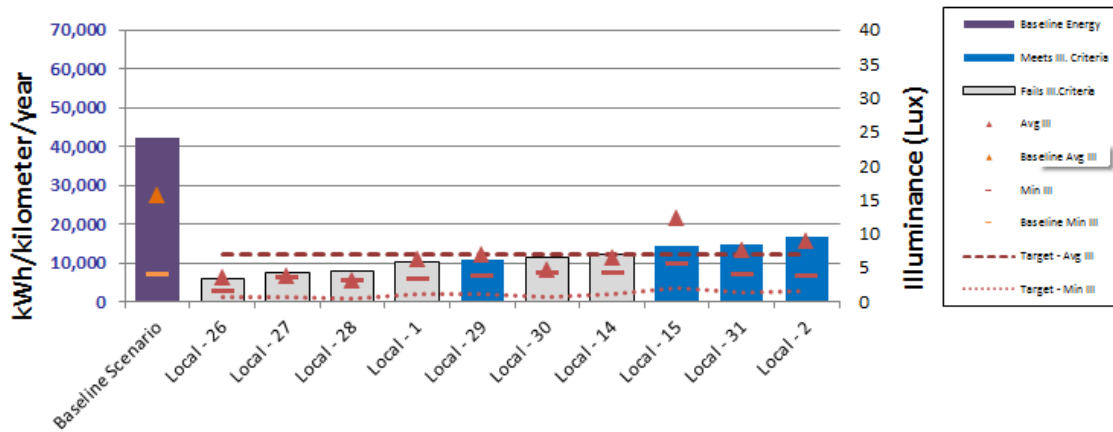
Sort by NPV

Sort by Average Illuminance

Sort by Average Luminance

More than 10 scenarios in Results page, use scroll bar to see additional results

## Annual Energy and Illuminance



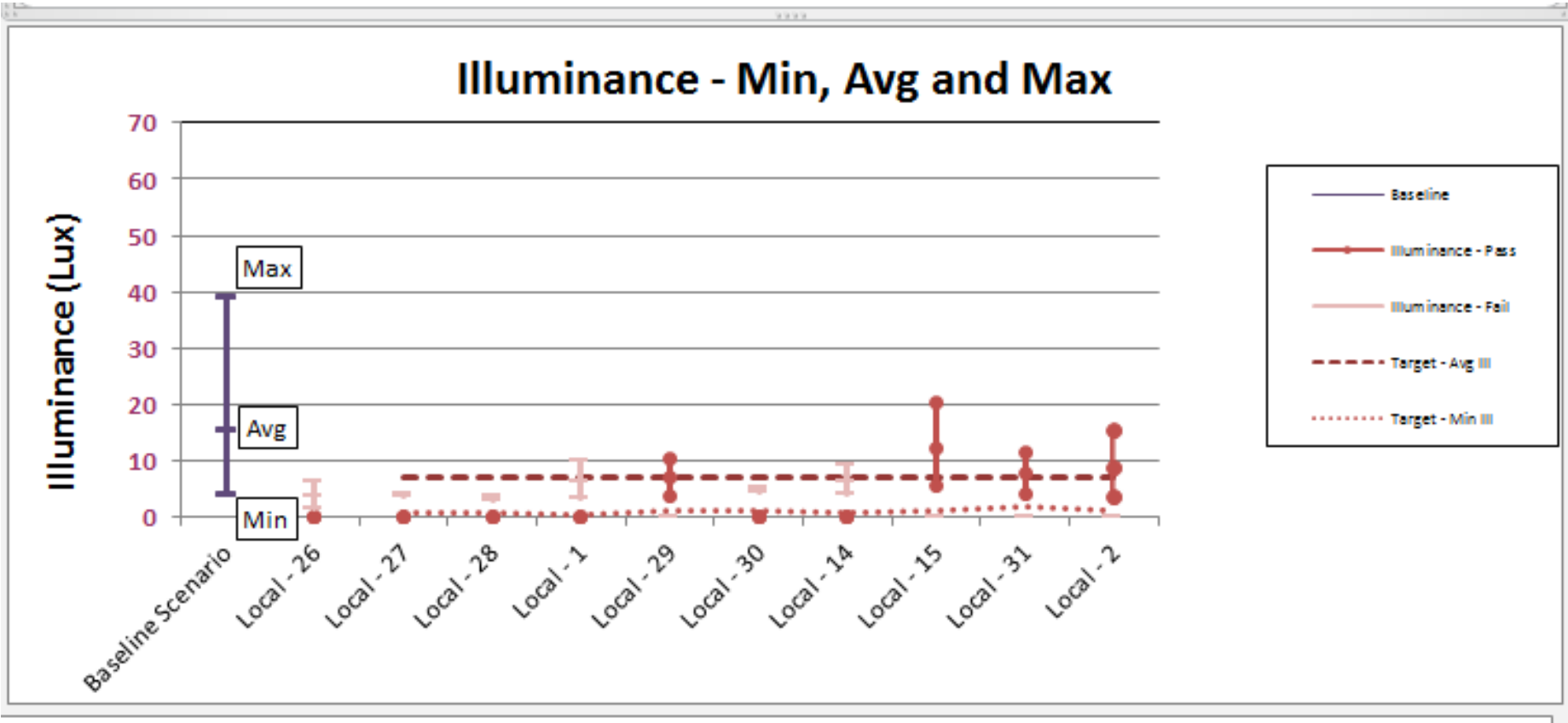
Print Chart



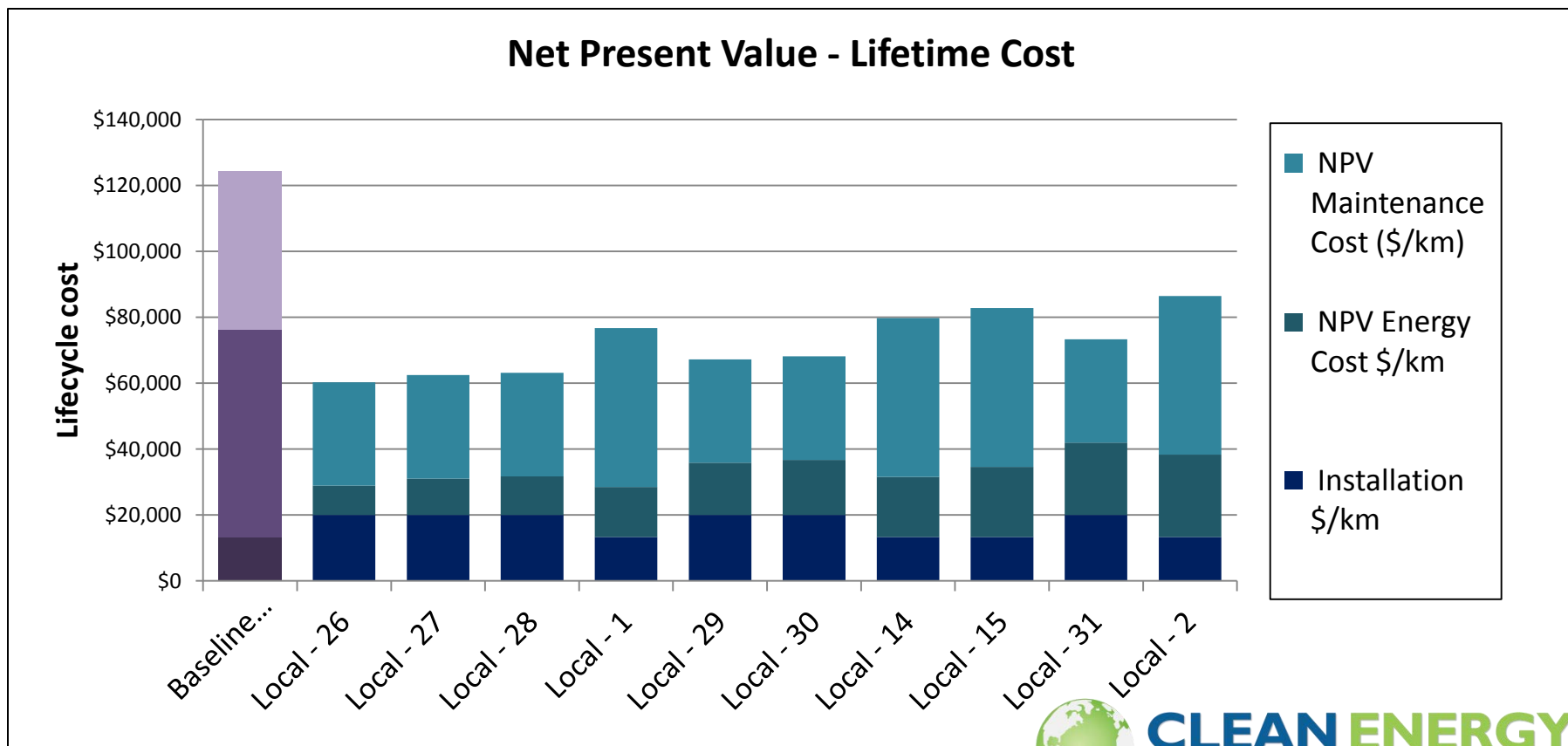
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# Batch Analysis Results



# Batch Analysis Results





# SEAD Tool – Planned Upgrades

- Usability
  - Definitions and clarifications
  - Potential training videos
  - Languages
- CIE calculation method
- Additional pole configuration scenarios
- Financial Inputs and Reporting

