Energy Efficient Street Lighting
MED MMCD Fall 2012

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Today's Presentation

Lighting basics and ROI examples

Provide updates on LED street lighting technology and standards

Retrofit process discussed

Cost benefits

Street Lighting Design

Majority of jurisdictions follow standards of the Illuminating Engineering Society and / or Transportation Association of Canada guides

MMCD have developed a design guide based on these standards and will be issued soon?

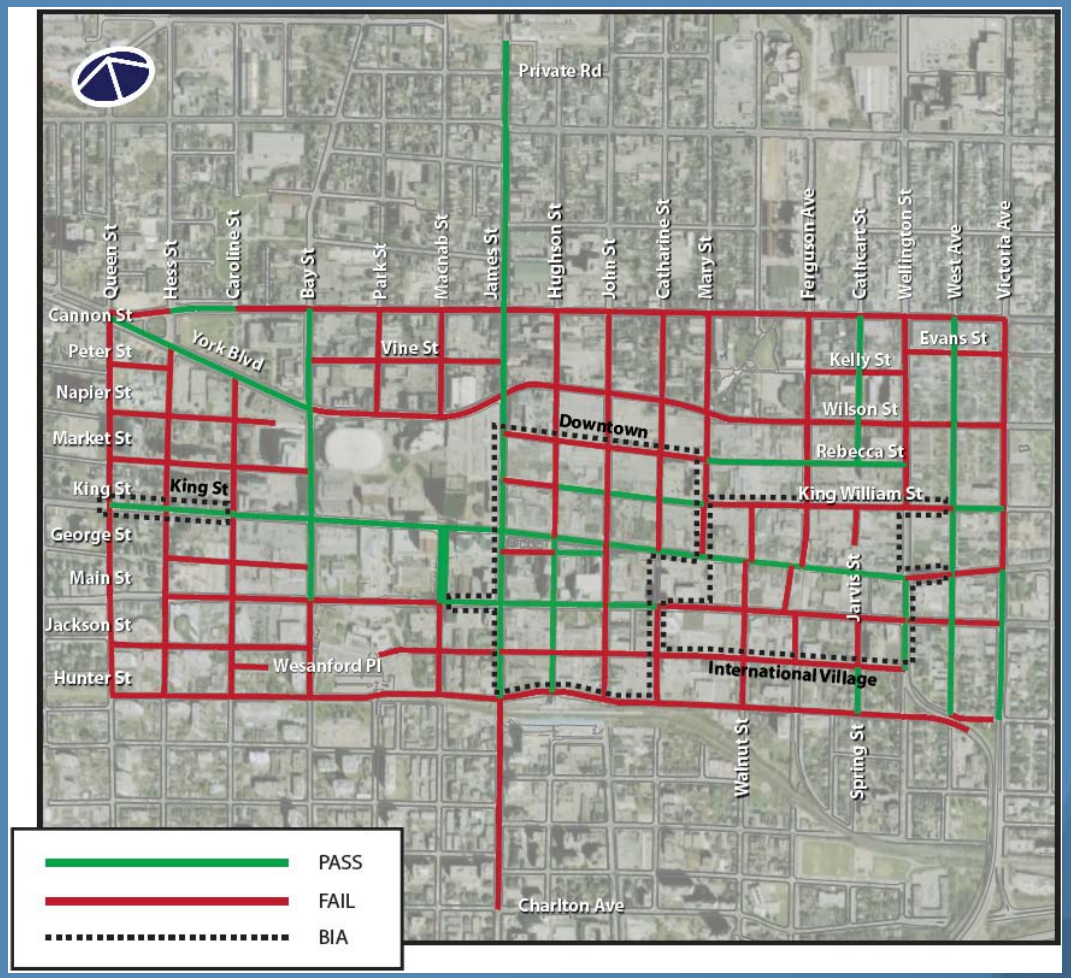
Both IES and TAC standards being revised and will be issued in 2013? MMCD will take in account majority of changes

This will impact city bylaws as they reference or duplicate information in these standards

Sidewalk Lighting

Pedestrian Activity	Maintained Average Horizontal Illuminance (lux)	Average-to - Minimum Horizontal Uniformity Ratio	Minimum Maintained Vertical Illuminance (lux)
High	≧ 20.0	≦ 4.0	≧ 10.0
Medium	≧ 5.0	≦ 4.0	≧ 2.0
Low	≧ 3.0	≦ 6.0	≧ 0.8

Design Issue - Sidewalk Lighting (Often not Considered)



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Sidewalk Lighting – Security and Safety

Safety

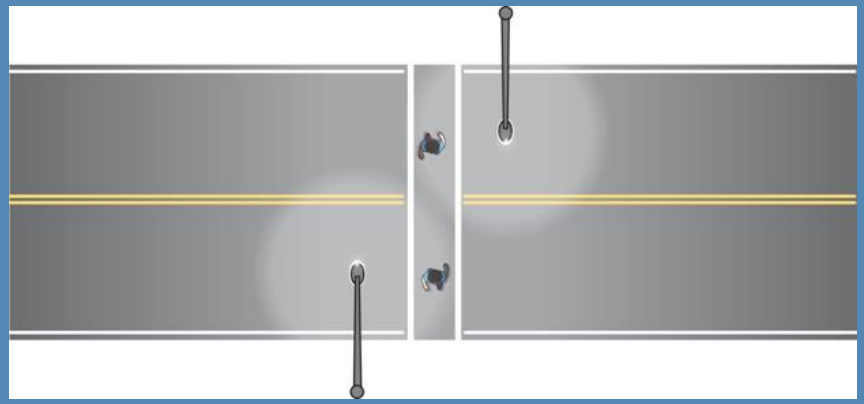
1. Pedestrian need light for guidance. Motor vehicles have headlamps

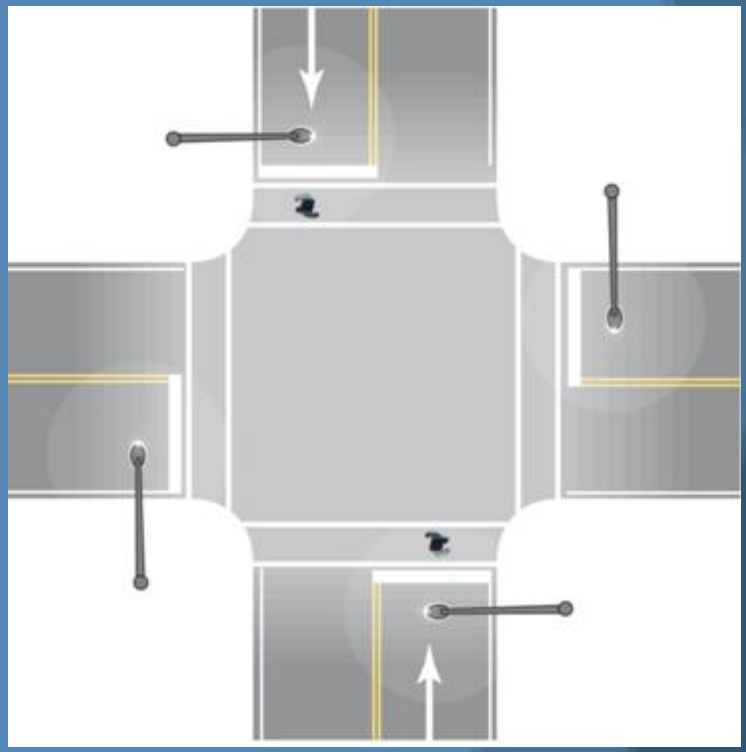
Security

1. Crime Prevention Through Environmental Design (CPTED) – Police driven initiative.
2. Light does not prevent crime however it does
   - aid in surveillance
   - Provide a feeling of security
   - Observe potential conflict form a distance and choose alternate route (fight or flight)
3. Lighting not always of benefit – Remote areas, etc. Lighting with limited surveillance can make one less safe

Sidewalk Lighting - Surrounds

Intersection Lighting – Vertical Illumination





LED's

Fact

- Technology has evolved at a rapid pace
- Optical systems vary widely.
- High potential and suppliers have invested heavily
- Adaptive controls easy to integrate however must allow for.

Unproven

- Long term field proven performance

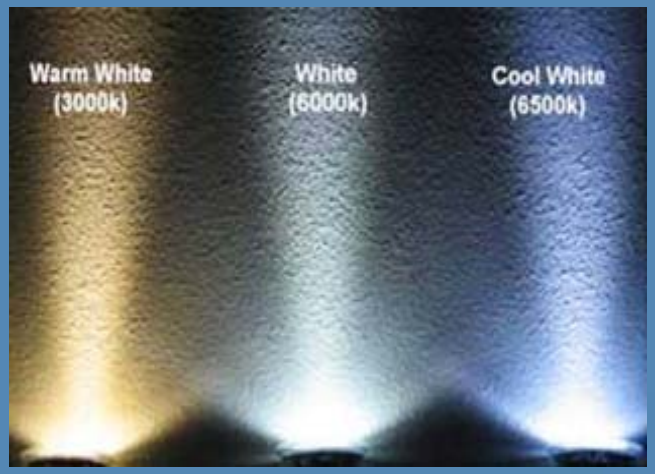
Significant Issues

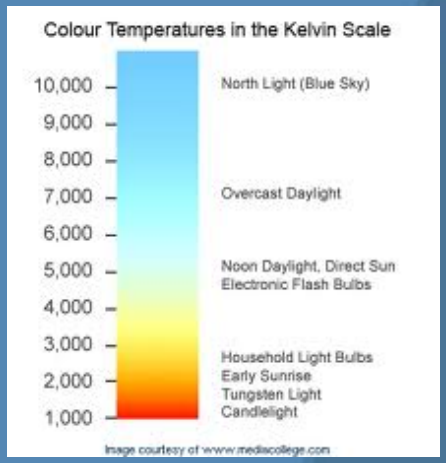
Issues:

- New LED technologies with outstanding light beam control can impact sidewalks and vertical lighting elements.
- High colour temperatures increase efficiency however some believe their may be health impacts.
- Many waiting for product to evolve however R&D is reduced as products are available

Colour Temeprature

Consider 4300 kelvin or lower (moonlight)





Optical Systems

- High efficiency
- Effective optical distribution – leads to improved uniformity
- Great cut-off
- Varying optical designs

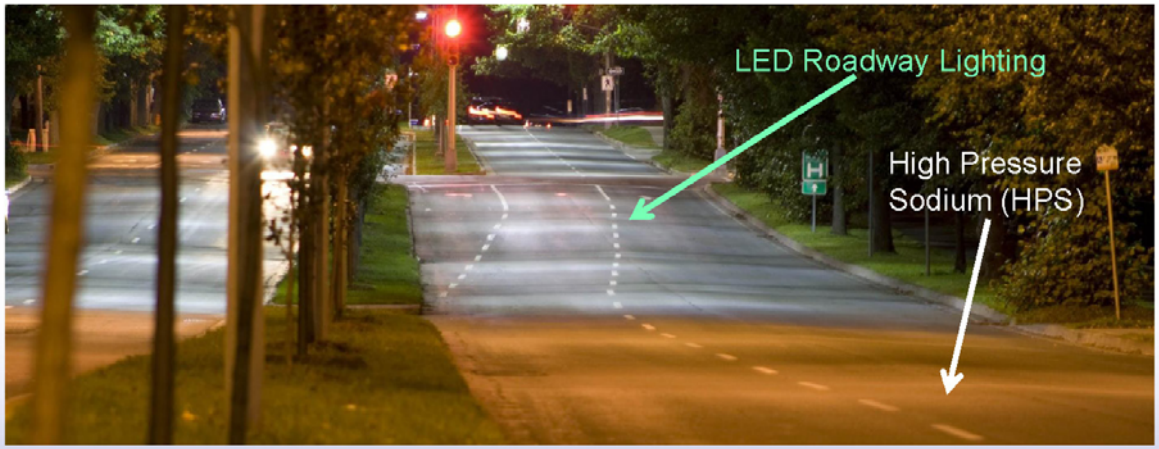
Design

- Sidewalk lighting levels
- Pole heights (lower)

Nova Scotia LED Pilot Results

An energy savings of *53%* will be gained from retrofitting the 1100 existing cobra head luminaires with LED luminaires.

Halifax, Nova Scotia (Robie St) - 55% Energy Savings



196 Watts
HPS - 150W Bulb

88 Watts
Satellite™ 96 LED-280mA

Recent Studies / Retrofits / Pilots

- TAC Roadway Lighting Design Guide (national publication)
- TAC Light Level Reduction and Energy Efficiency Guide (national publication)
- US Federal Highway Lighting Handbook (national publication)
- Edmonton – Green standards / energy reduction
- Edmonton LED Retrofit (8,000 lights so far – 90,000 upcoming)
- Lethbridge – LED Retrofit (20,000 lights over 5 years)
- New Brunswick Power – LED Retrofit (80,000 lights so far)
- Nova Scotia LED retrofit (1,600 lights)
- Hamilton Study – Energy efficiency
- Nova Scotia (UNSM) – Energy efficiency review
- LED specs –Edmonton, Fort St John, Coquitlam, Surrey, Thunder Bay, Lethbridge, New Brunswick, Nova Scotia, Hamilton, Medicine Hat, Port Moody, etc.
- Surrey – LED pilots and review and field measurements
- BC Hydro – 15+ adaptive lighting studies
- Coquitlam LED pilot
- Nova Scotia LED pilot
- NRCAN Adaptive Lighting pilots (20 all across Canada)
- Prince George Adaptive Lighting Pilot (500 lights), WRB Bridge-Kelowna, Highway 1 East of 176 St – Surrey, DMD office-Surrey
- BCH Adaptive Lighting Deployment Guide
- Surrey Adaptive Lighting product review
- City of Medicine Hat LED Retrofit
- City of Calgary LED Retrofit
- Port Moody Retrofit Review
- City of Las Angeles LED Retrofit (100,000 lights and counting)
- City of Glendale Adaptive Lighting Retrofit (18,000 lights)
- Nova Scotia (law) LED retrofit (150,000 lights)
- London, UK LED Retrofit (30,000 lights)
- Welland, Ontario LED Retrofit with Adaptive Controls (6,700 lights)
- Central Park, New York LED Retrofit (2,200 lights)

LightSavers Canada

LightSavers Canada is a national market consortium that aims to step up the adoption of LED lighting and smart adaptive controls in certain general illumination applications.

LightSavers Canada will assist municipal and provincial governments, public institutions, and private companies that own or manage lighting assets to learn from each other about LED and smart control performance, procurement, and financing.

www.lightsavers.ca

TAC Light Level Efficiency and Power Reduction Guide (Draft)

- Technology and products have been developed quicker than standards and application.
- Need for National Publication.
- Sound basis of science, research and logic.
- Defines a complete process to assess and deploy energy efficient street lighting.
- Available spring / summer 2013.
- Guide will be used by cities, lighting designers and suppliers.

TAC Light Level Efficiency and Power Reduction Guide (Draft)

www.dmdeng.com

LED Considerations

Cost - Better quality LED street lights can be over *$1,000* whereas a typical cobra head luminaire is typically around $200. Some of lower wattage LED's now around $400.00 - 500.00. *Consider ROI over payback*

Light Loss Factor – A factor which is applied to all lighting to compensate for lamp depreciation over time. Lighting levels are based on end of lamp life. As LED's can last for 20+ years this is key factor. *Calculations and complex and should be reviewed by experienced personnel.*

Standardization - LED roadway luminaires are relatively new to the market. Specifications under development. *Should be performance based. DMD have developed proven specs which continue to be refined.*

Lack of Proven Long Term Performance - As LED roadway luminaires are new to the industry, long term performance has not been field proven. *This can be overcome with longer warranty period and MTBF analysis.*

Key Product Elements - Performance

Define by unit power density (watts per area of roadway

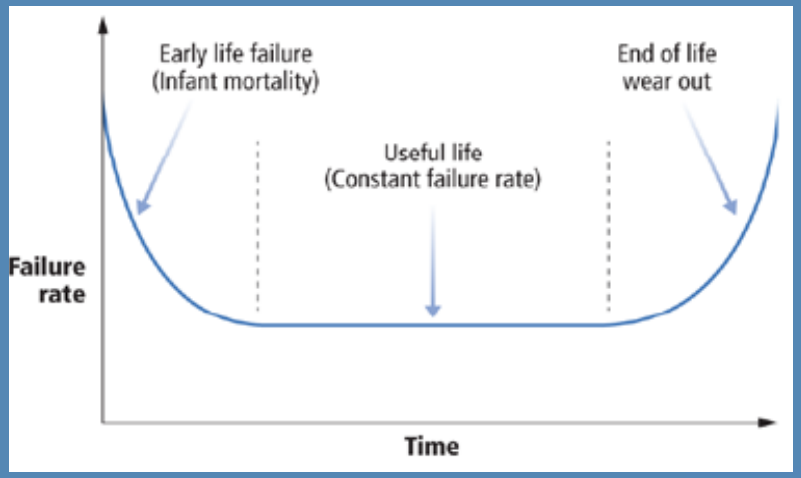
Base on typical roadways which exist

Lowest UPD defines best optically efficient luminaire

Key Product Elements - Reliability

Reliability – Mean Time Between Failure (proven prediction model)

Telecordia SR332 method



Key Product Elements - Quality

Review samples

Define product testing (salt spray, ingress protection, vibration, etc)

Key Product Elements - Functionality

Ease of installation

Appearance

Warranty – 10 years?

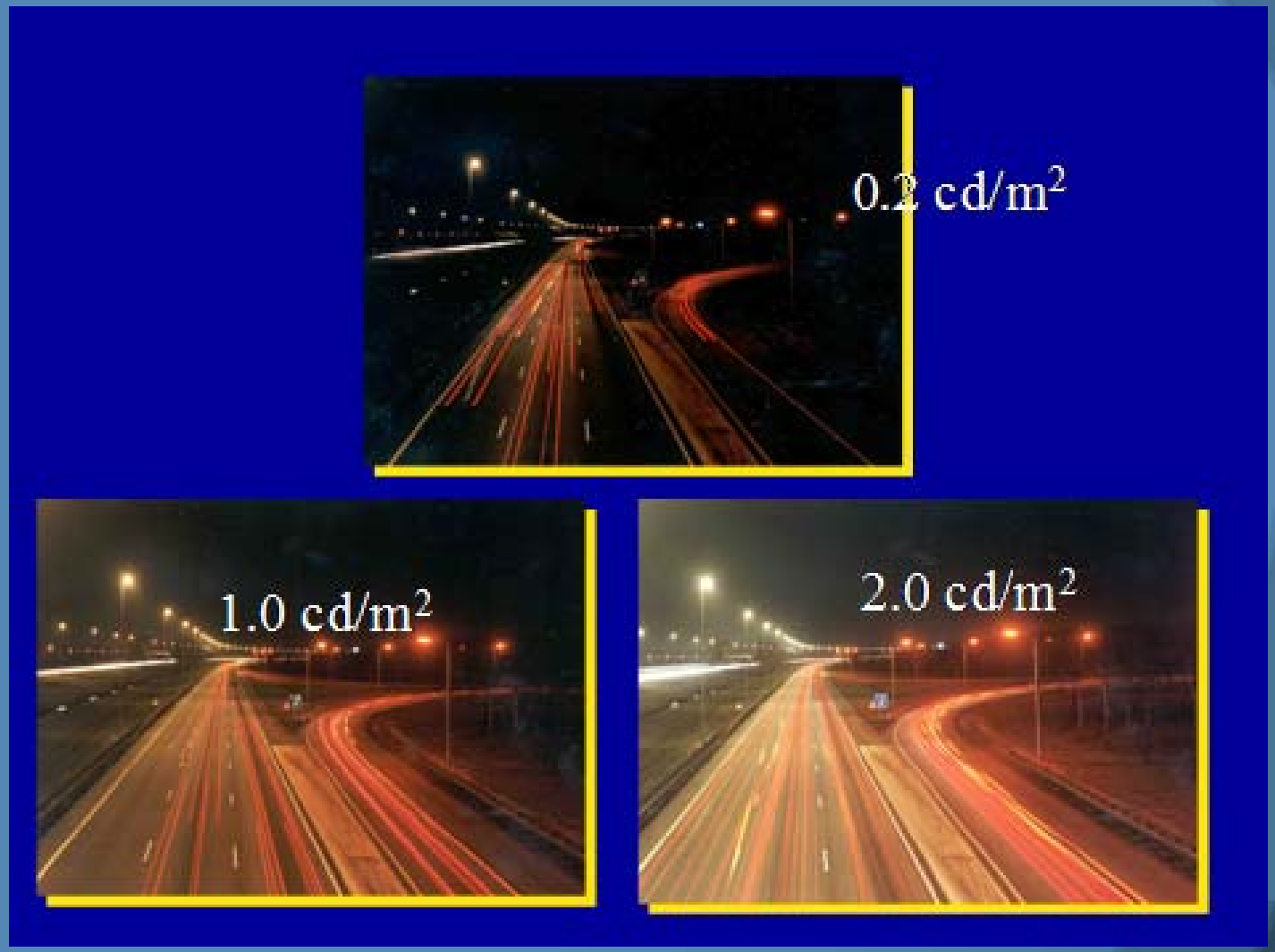
Adaptive Lighting

"The ability to vary lighting levels to suit activity levels."

Becoming accepted practice in many published documents

Bill in US Congress mandating adaptive controls for all new outdoor luminaires by 2013. Not law yet however…

Adaptive Lighting Example



Potential Benefits/Issues?

- Reduced Energy Consumption – Studies show 20% to 30% on average for most Cities while still meeting required light levels
- Obtrusive Light Reduction – Less light off site while people are sleeping
- Power Consumption Monitoring – Can be used to validate costs
- Streamlined Asset Management – Benefits maintenance
- Legal issues ?? VTTI exploring –

Return of Investment and Payback

Simple ROI = Gain from investment - cost of investment / cost of investment x 100

Payback = Cost of investments (supply and install) / Gain for Investment (power and maintenance costs)

LED's

Gain from Investment = $881,000.00

- Define luminaire life:
  1. 20 years
- Energy savings:
  1. 100W HPS Replaced with 50W LED therefore $0.065kW/h x 0.05kW x 1000 lums x 4200 hours = $13,700 x 20 years = $274,000.00.
- Maintenance cost savings:
  1. Reliability – Assume much higher with LED – Failure rate 10% for HPS versus 1% for LED therefore assume $150.00 per call out and repair = $120.00 x 0.09 x 1000 = $11,000 x 20 years = $220,000.00
  2. Re-lamping – Assume 3 re-lamps required however as LED would need to cleaned at say 10 years allow for 2 only = $120 x 2 x 1000 = $240,000.00
- Inflation and cost increase factor:
  1. 20%

LED's

Cost of Investment = $600,000.00

- Luminaire supply cost
    1. $450.00 x 0.12 (taxes) x 1000 lums = $540,000.00
- Installation cost
    1. $60.00 x 1000 lums = $60,000.00

Benefits for LED's

- Simple ROI = $881K - 600K / $600K x 100 = 47%
- Payback = 20 years without 20% factor

Benefits for LED's and Adaptive Controls would be similar

LED's – Suppliers Assessement

Current Inventory

Fixture	Watts	Qty.	Unit Power $/Yr.	Annual Maintenance Cost	Annual Operating Cost
70W HPS	95	3440	$24.97	$137,600.00	$223,483.04
100W HPS	135	1680	$35.48	$67,200.00	$126,803.04
150W HPS	195	2160	$51.25	$86,400.00	$197,091.36
250W HPS	295	640	$77.53	$25,600.00	$75,216.64
400W HPS	465	80	$122.20	$3,200.00	$12,976.16
		8000			**$635,570.24**

LED Replacements

Fixture	Watts	Qty.	Unit Price	Unit Power $/Yr.	Annual Maintenance Cost	Annual Operating Cost
SAT-24S-525	44	3440	$370.00	$11.56	$1,324.11	$41,101.52
SAT-48S-350	57	1680	$447.00	$14.98	$540.15	$25,705.88
SAT-48S-600	100	2160	$447.00	$26.28	$958.88	$57,723.68
SAT-96M-450	143	640	$744.00	$37.58	$401.94	$24,453.40
SAT-96M-600	201	80	$744.00	$52.82	$59.76	$4,285.58
		8000				**$153,270.06**

Price per LRL fixture may vary, this is not a quote.

Key Statistics

Re-lamp Costs	$160.00
Energy Cost	$0.06 /kWh
Re-lamp Timing	4 years
Inflation Rate (multiplier)	1.05
Total Unit Cost	$3,524,960.00
Total Watts Saved	630,080
Energy Saved/Yr (MWh)	2,759.8
Energy Saved 20 Yrs (MWh)	55,195.0
Tonnes GHG reduced/Yr	44
Tonnes GHG reduced 20 Yrs	883
# of Cars Permanently Removed	8
Total # of street lights in the project	8,000

LED maintenance based on 302.949 year total of 201 to 258 (driver + maintenance per failure) depending on unit driver cost.

* There is a slight discrepancy in the first year savings due to drivers being covered by warranty for the first 5 years. This results in the difference of 1012.72 seen in the table.

	Year	Annual Savings	Accumulated Savings	
*	1	$483,335.28	$483,335.28	
	2	$507,502.04	$990,837.32	
	3	$532,877.14	$1,523,714.46	
	4	$559,521.00	$2,083,235.46	
	5	$587,497.05	$2,670,732.51	
	6	$616,871.90	$3,286,311.71	**6.4 Years**
	7	$647,715.50	$3,932,669.87	
	8	$680,101.27	$4,611,345.93	
	9	$714,106.34	$5,323,955.80	
	10	$749,811.65	$6,072,196.17	
	11	$787,302.24	$6,857,848.55	
	12	$826,667.35	$7,682,783.55	
	13	$868,000.71	$8,548,965.30	
	14	$911,400.75	$9,458,456.13	
	15	$956,970.79	$10,413,421.51	
	16	$1,004,819.33	$11,416,135.16	
	17	$1,055,060.29	$12,468,984.49	
	18	$1,107,813.31	$13,574,476.29	
	19	$1,163,203.97	$14,735,242.68	
	20	**$1,221,364.17**	**$15,954,047.39**	**Total Savings**

Retrofit and Deployment

- Inventory – Define what exists poles, spacing, road types, widths, sidewalks, lighting criteria, etc. Use city GIS system. Many roads are over lit to achieve require uniformity. LED's have many more optical distribution choices than what exists. Proper analysis and assessment of optical systems is how you achieve 50%-60% energy savings.
- Design – Lighting calcs to define luminaire distribution and wattage and to make sure required lighting levels are achieved.
- Specifications – Develop and issue
- Procurement – Issue specs and review submittals to define bet value
- Test and Commission – Required for adaptive controls
- Monitor and review – During construction
- Public and Communications Program – Pre and post Construction

Product Procurement

Performance (30 points)

Review and rate:

Review data submitted for correctness.

Comparison of UPD ratings. Best accepted UPD should score the highest points.

Ability to meeting light level, uniformity, and veiling luminance lighting requirements.

Rate features and options provided.

-

Product Procurement

Quality and Longevity (40 points)

Review and rate:

A review of data submitted for correctness.

Review Mean Time Between Failure (MTBF) results, as this a critical element.

Review of testing data and reports for compliance.

Product review. Actual luminaire submitted should be reviewed.

Product Procurement

Cost (30 points)

Can be scored based on a relative pricing formula.

If a supplier bids $12,000.00 and that is the lowest bid price, that proponent receives 30 points 100% of the possible points for that category(12,000/12,000 = 100%).

A proponent who bids $24,000.00 receives 50% of the possible points for that category ($12,000/$24,000 = 50%), and a proponent who bids $24,000.00 receives a score of 15 possible points (50% of 30 points) for that category.

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Questions and Answers