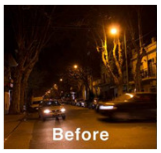
Good morning

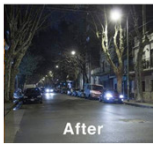
Washington Transportation Professionals Forum (WTPF)

Spring Westside Meeting on LED lighting and controls

June 3, 2015
at Thurston County Public Works

- Networking time: 8-8:30 a.m.
- Meeting and webinar: 9 a.m.-12:30 p.m.
- More networking time: 12:30-1 p.m.





Photos: Media.treehugger.com

Hello and welcome to the:

Washington Transportation Professionals Forum

Webinar attendees and In person attendees

Freephoto.com

Thurston Co. Emergency Coord. Center (KMBDesign.com)

Instructions for webinar attendees

- Press the orange arrow toggle button to show and hide the GoToWebinar screen.
- You are in listen-only mode. Please ask questions and make comments by typing them in the "Questions" box. We will read your question to the presenter for an answer.
- Please take breaks when needed.
- Have fun connecting across the state!

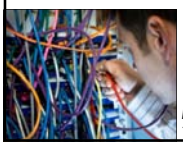


Photo courtesy of Pacific Technologies, Inc.

Instructions for in person attendees

- So the webinar attendees and in-person attendees can hear better:
  - ✓ Please turn wireless devices to silent mode.
  - ✓ Move side conversations out of the room.
  - ✓ Speak loudly and clearly. We will try to repeat all questions.
- Take breaks when needed:
  - ✓ Can move around the back and sides of the room.
  - ✓ Restroom locations.
  - ✓ Food, vending machine.
- Fire exits.
- Have fun connecting across the state!

Introductions

Please tell us your:

- Name
- Agency/Business name
- Announcement? (10 seconds or less)

Blackbookdepot.com

Washington Transportation Professionals Forum

- Founded ~1978-1979 (36+ years ago) as the Urban Traffic Engineers Council (UTEC).
- Formed by city traffic engineers. Met informally for lunch to discuss common issues – mostly to develop traffic analysis and collision analysis software.
- Group grew as other cities and also counties learned about the group. Consultants, vendors, and other agencies joined next.
- As of April 2015, 68% of members statewide had attended a meeting in person or by webinar in the past 5 years.
- May 2015: All cities/towns with pop. less than 12,000 added. Now approx. 655 members.
- Planning committee helping to define who we are, who we need to be, and how.

Overview/Agenda

- What are LED roadway lighting and adaptive control systems in a nutshell?
- Roadway lighting reform: WSDOT's journey on rethinking why we light
- Energy savings performance contracting (ESPC) (Overview of Washington State Dept. of Enterprise Services' ESPC Program
- 10 minute break
- Governor's Executive Order 14-04 (Washington Carbon Pollution Reduction and Clean Energy Action)
- Energy Efficiency and Solar Grant Program for Local Governments, State Agencies, and Higher Education

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Overview/Agenda

- The role of an energy services company in LED conversions: Bringing it all together
- State Lease Purchase and Local Program (as funding sources for LED conversions
- Utility incentives and rebates for LED conversions
- 15 minute break
- Case study 1: Relight Washington (Washington State Transportation Improvement Board's LED Streetlight Demonstration Project)
- Case study 2: City of Olympia's LED Streetlight Conversion Project
- Case study 3: WSDOT's LED Adaptive Lighting Pilot, US 101 in Olympia

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LED Roadway Lighting Update

Jim Sanborn

zuli
INTEGRATED LIGHTING SOLUTIONS

6-3-15

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LED *Key Points*

- 60% more efficient than comparable HID luminaires
- Longevity with low maintenance
- "White light" improves visibility on roadways
- Surge protection UL 1449 10KVA/5kA (Must be Specified)
- Tool-less access
- Sleek attractive dayform with weight and EPA less than existing HID cobraheads
- Flexibility for simplified inventory
- Accommodates voltage drop

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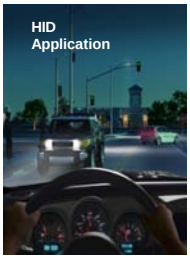
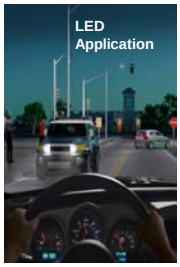
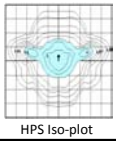
Better Lighting Uniformity



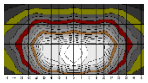
Better illumination:

- Improved visibility – Safer driving and pedestrian environment
- Retrofit without sacrificing performance
- Better spacing and uniformity than HPS
- Improved visual comfort





HPS Iso-plot



LED Iso-plot

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Also Not All LED Fixtures Perform Equally

IES ROAD REPORT
PHOTOMETRIC FILENAME : GE453745.IES

FLUX DISTRIBUTION 305 Watts

	Lumens	Percent Of Lamp
Downward Street Side	12207.9	43.6
Downward House Side	8545.3	30.5
Downward Total	20753.2	74.1
Upward Street Side	118.5	0.4
Upward House Side	121.3	0.4
Upward Total	239.8	0.9
Total Flux	20993.0	75.0

IES ROAD REPORT
PHOTOMETRIC FILENAME :

FLUX DISTRIBUTION 213 Watts

	Lumens	Percent Of Luminaire
Downward Street Side	17715.8	82.8
Downward House Side	3676.2	17.2
Downward Total	21392.0	100.0
Upward Street Side	0.0	0.0
Upward House Side	0.0	0.0
Upward Total	0.0	0.0
Total Flux	21392.0	100.0

FLUX DISTRIBUTION 227 Watts

	Lumens	Percent Of Luminaire
Downward Street Side	11583.3	65.2
Downward House Side	6185.4	34.8
Downward Total	17768.7	100.0
Upward Street Side	0.0	0.0
Upward House Side	0.0	0.0
Upward Total	0.0	0.0
Total Flux	17768.7	100.0

Surge Protector Tutorial

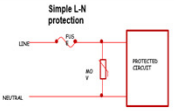
UL 1449 – Standard for Safety – Surge Protective Devices

- Covers devices intended for permanently connected, cord-connected and direct plug-in applications.
- Requires a fuse in order stop current flow in the event of MOV thermal failure.

NFPA 70 National Electric Code (NEC) 2008

- **Article 285.5** – SPDs shall be Listed
- **Article 285.6** – SPDs shall be marked with a short circuit current rating (SCCR), and shall not be installed at a point on the system where the available fault current exceeds the SCCR of the SPD
- **Article 285.26** – Conductors used to connect the SPD to the system shall be greater than 14 AWG copper, or 12 AWG aluminum
- **Article 285.27** – SPDs shall be permitted to be connected between any two conductors of the system: grounded, ungrounded, or grounding conductors. Connection of the grounded and grounding conductors shall only be interconnected during a surge.

Simple L-N protection



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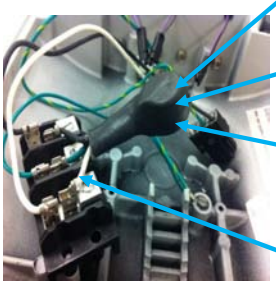
Surge Protector Posers – What to Look For



- Does not display a UL or CSA marking; non-compliance with Article 285.5
- Does not describe short circuit current rating; non-compliance with Article 285.6
- Does not incorporate fusing such that SPD becomes disconnected after MOV failure; non-compliance with Article 285.27
- May not be 14AWG Wires; possible non-compliance with Article 285.26

Insufficient protection will reduce fixture life.

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Catastrophic Event

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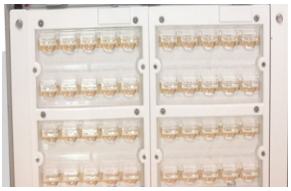
Two types of LED Chips



Discrete chips (small)

COB chips (large)

COB's are replacing Discrete do to lower cost.

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Drive Current, What is it?

LuxeonTX

Drive Current	Vf	Watts	HP Lumen Output	MPG Efficacy LPW
350mA	2.71V	.95	147	155
700mA	2.80V	1.96	269	137
1050mA	2.86V	3.00	360	136

The harder you drive an LED the less efficient it is, but remember the Prius in not necessarily going to "last" longer than the Porsche.

134 HP, 50 MPG / 0-60 MPH 11 sec.

408 HP, 17 MPG / 0-60 MPH 3.7 sec.

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What Determines Life?

Heat = Life

An LED driven at 1050mA with a Tc (case temperature) of 85C will outlive the same LED driven at 530mA with a Tc of 90C

Life = Tc
Drive Current = Efficiency

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Drive current and fixture specification

- **Each LED package has different maximum current and junction temperature specifications**.
- **The drive current that pushes one past its thermal limits may be well within another's operating limits.**
- **Managing the thermal load is key to operating an LED within its performance limits.**
  - **An LED that is properly heatsinked can withstand higher drive currents.**
  - **The key is to draw heat away from the LED junction so that it reaches thermal equilibrium below its max allowable temperature.**
- **Not all manufacturers test at the same ambient temperature range it varies between 15 degree C-40 degree C**
- **Consider fixture construction, latching and other small items. The LEDs are designed to last !!**

But is the housing holding it together going to last too. !!

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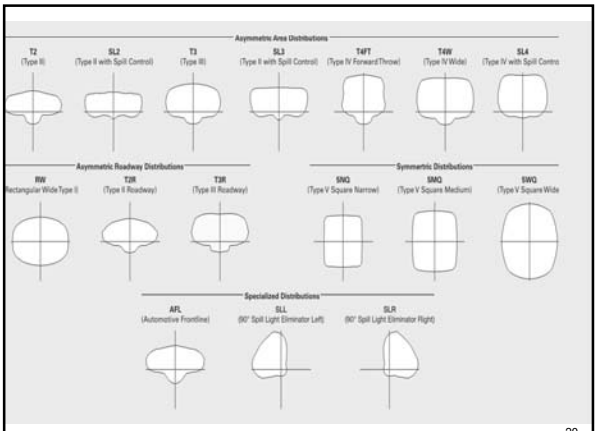

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Finally no more of these !!!!

Thanks for inviting me to speak

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Controls

Embedded "Stand-Alone" Controls

Wireless Monitoring and Control

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Control Options

Feature	Operational Definition	Fixture Option
NEMA 3 Pin Photocontrol Receptacle	ANSI standard locking style receptacle that accepts 3 pin controls for On/Off operation	Default
NEMA 5 Pin Photocontrol Receptacle	ANSI standard locking style receptacle that accepts 3-pin & 5-pin controls. The unit is provided with a 0V - 10V dimming driver with low voltage leads connected to pins 4 & 5 on the receptacle.	P5
NEMA 7 Pin Photocontrol Receptacle	ANSI standard locking style receptacle that accepts 3-pin, 5-pin, and 7-pin controls. The unit is provided with a 0V - 10V dimming driver with low voltage leads connected to pins 4 & 5 on the receptacle.	P7
Premium Solid State Photocontrol	Premium Dark to Light®, DSS solid state approved locking style photocontrol with 10 year rated life and 5 year warranty	PCSS
Extreme Long Life Solid State Photocontrol	Premium Dark to Light® DLL solid state approved locking style photocontrol with 20 year rated life and 10 year warranty	PCL1
Local Remote On/Off Control	Premium Dark to Light®, DCC solid state approved locking style photocontrol that remotely connects with a DCR (remote control) to provide on-demand on/off control of the luminaire. 15 year rated life and 10 year warranty.	PCCC
Field Adjustable Output	Onboard module that adjusts the light output and input wattage to meet site specific requirements, allowing a single fixture configuration to be flexibly applied in many different applications	AO
Remote Wireless Monitoring & Control (On/Off/Dim)	The ability to monitor and control the fixture from a remote location using a wireless network. The control must be purchased separately and attached to the fixture through the photocontrol receptacle.	P3 (default) , P5, P7

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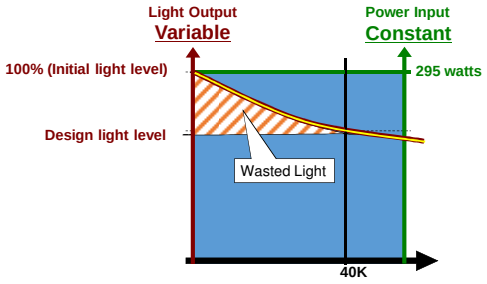
Lumen Management



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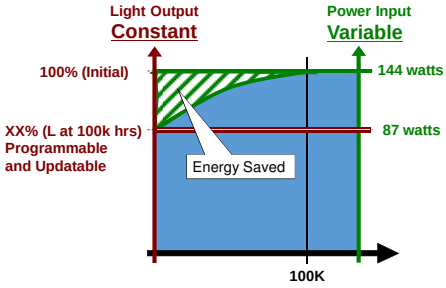
Lumen Management - CUSTOM



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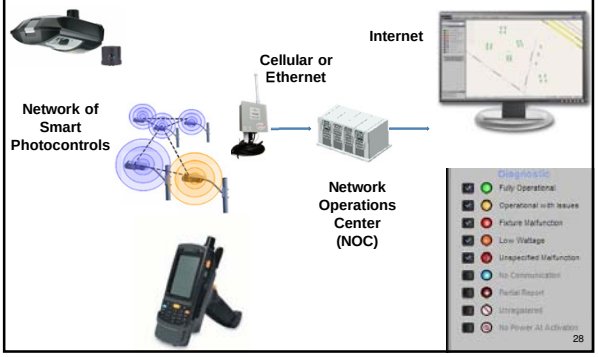
How Wireless Control Works



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Wireless Dimming Node

- Uses ANSI C136.41 receptacle (5 or 7 pin)
- Combines dimming and monitoring capabilities in one control
- Available in all voltages 120-277V, 347V, 480V
- Revenue grade metering capability to C12.20 (0.5%)
- Optional onboard GPS chip
- Available with CULUS

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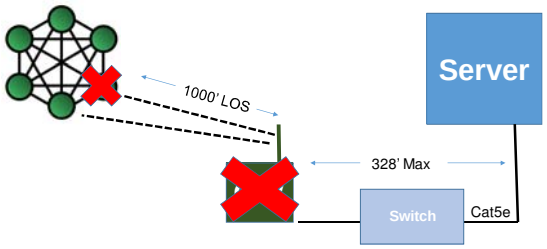
Mesh Network



A mesh network is a network topology in which each node relays data for the network. All mesh nodes cooperate in the distribution of data in the network.

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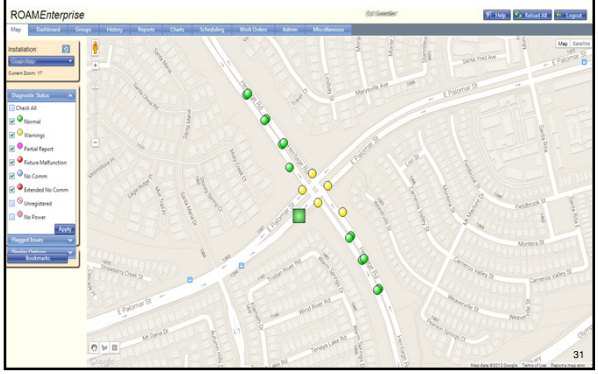
Customer Portal



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The Gateway

Multi-volt (120 – 277V)

- Receives Commands From the Network Operation Center (NOC) and Forwards to the Nodes
- Receives Fixture Data from the node and Forwards to the NOC
- Can Communicate Using Cellular* or Ethernet Connection
- One Gateway Can Manage Up to 2,000 Photocells

* Currently AT&T

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The Server

1000 – 5000 Nodes

Operating System: Windows Server 2008, 64Bit
CPU: Dual Core, 2.5 GHZ+
RAM: 4 GB
Drive Space (separate from OS drive): 50 GB

5000 – 15000 Nodes

Operating System: Windows Server 2008, 64-bit
CPU: Quad-core CPU
RAM: 8 GB
Drive Space (separate from OS drive): 250 GB

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System Activation

- Rugged Hardware
  - Sub 2 meter GPS
  - Touch screen
  - Barcode Reader
  - Weather and drop proof
  - IP67 Waterproof/dustproof
- Customized Software Interface
  - Collection of asset attributes
  - Customized for each installation
- Efficient
  - 3-5 min. data collection and installation

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Today's Most Common Sensing Platform

…the smart phone…

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Tomorrow's most common sensing platform…

….the intelligent luminaire

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One Network, Multiple Sensors

SIMPLE

Video Camera

Traffic Analytics

Parking System

+ 100's of additional Apps

1 Standards-based, High-Bandwidth Network

No Trenching, No New Installs – Leverage existing assets

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One Platform, Many Services

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Illumination Reform

WSDOTs journey on rethinking why we light

Ted Bailey, P.E.
Traffic Operations Business Manager
Washington State Department of Transportation

Ida van Schalkwyk, Ph.D.
Safety & Operations Technical Engineer
Washington State Department of Transportation

Lynn Peterson
Secretary of Transportation

Washington Transportation Professionals Forum
Olympia, WA
June 3, 2015

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Main Points

- Setting the stage
- Illumination Reform – ***Rethinking why we light***
  - Crash reduction research & incorporating predictive modeling into lighting decision-making
  - WSDOT *Design Manual* Changes

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SETTING THE STAGE

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The nature of DOT business is changing

- Transitioning from capital capacity projects to operating and maintaining the current system
- Moving away from "being standards based" and toward "context based solutions" that directly and cost effectively address the problem.
- And, at the same time aligning with the priorities of the Governor and WSDOT
- Excerpts from WSDOT Executive Order 1090.00, " Moving Washington Forward: Practical Solutions" (August 20th, 2014):
  - "Designers are directed to use quantitative methods as outlined in the **Highway Safety Manual (HSM)** and associated analytical tools to identify alternative designs that achieve substantive versus nominal safety improvements."
  - **Least cost planning**: Consider a variety of solutions to achieve the desired performance at the least cost
  - **Practical design**: Focus on the problem and seek solutions with the best return on investment to meet the outcomes that communities and stakeholders have identified. Practical design allows more flexibility and freedom to innovate.

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Alignment with WA Strategic Plan & Governor Priorities

GOAL 3: SUSTAINABLE ENERGY AND A CLEAN ENVIRONMENT

Building a legacy of resource stewardship for the next generation of Washingtonians

RESULTS WASHINGTON

TAINABLE AND CLEAN ENE

Reduce our greenhouse gas emissions

CLEAN TRANSPORTATION	CLEAN ELECTRICITY
1.1 Reduce transportation-related greenhouse gas emissions from 44.9 mmt/year (projected 2020) to 37.5 mmt/year (1990) by 2020	1.2 Reduce greenhouse gas emissions from electrical energy consumption from 18.4 mmt/year (projected 2020) to 16.9 mmt/year (1990) by 2020

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WA Carbon Pollution Reduction & Clean Energy Action

Governor's Executive Order 14-04

"… develop, and implement to the extent possible and consistent with state and federal law, a new statewide program…

The program must include the following measures:…

Upgrade the energy efficiency of all street lighting within the state…"

http://governor.wa.gov/office/execorders/documents/14-04.pdf

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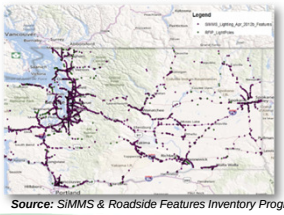
WSDOT Illumination Systems 2014

- Existing systems: 3,100 *(400 installed since 2005)*
- Roadway light fixtures: 60,000



• Cobra Heads	48%
• Sign Lights	2%
• Pole Top	3%
• Underdeck	14%
• Wall Mount	2%
• Shoe Box	4%
• High Mast	3%
• Tunnel	24%
	100%

Source: *SIMMS & Roadside Features Inventory Program (RFIP) database*

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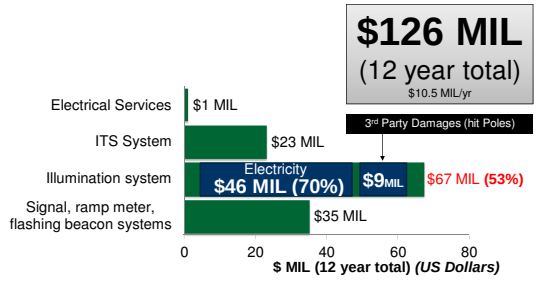
WSDOT Traffic Signals, ITS and Illumination Systems

Repair, non-preventative maintenance, electricity & 3rd Party Damages



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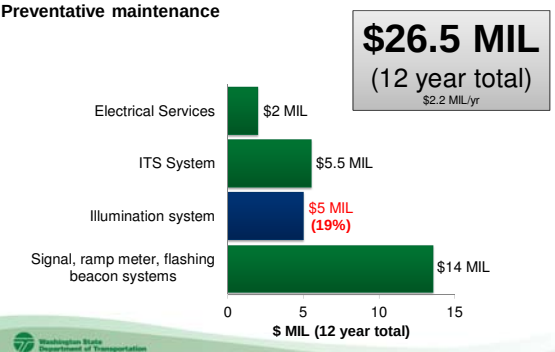
WSDOT Traffic Signals, ITS and Illumination Systems

Preventative maintenance



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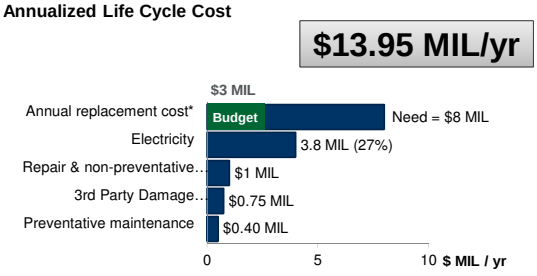
WSDOT Illumination Systems

Annualized Life Cycle Cost



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Why do we have so much lighting?

1974 - 1995

26.8 BCR

HIGHWAY SAFETY IMPROVEMENTS WITH THE HIGHEST BENEFIT-COST RATIOS 1974-1995

Rank	Improvement Description	Benefit Cost Ratio
1	Illumination	26.8
2	Upgrade Median Barrier	22.6
3	Traffic Signs	22.4
4	Relocated Breakaway Utility Poles	17.7
5	Remove Obstacles	10.7
6	New Traffic Signals	8.5
7	Impact Attenuators	8
8	New Median Barrier	7.6
9	Upgrade Guardrail	7.5
10	Upgrade Traffic Signals	7.4
11	Upgrade Bridge Rail	6.9
12	Improve Sight Distance	6.1
13	Median for Traffic Separation	6.1
14	Groove Pavement for Skid	5.8
15	Improve Minor Structure	5.3
16	Turning Lanes and Channelization	4.5
17	New RR Crossing Gates	3.4
18	New RR Crossing Flashing Lights	3.1
19	Pavement Markings and Delineation	3.1
20	New RR Crossing Lights & Gates	2.9

Federal Highway Administration (1996). The 1996 Annual Report on Highway Safety Improvement Programs. Publication No. FHWA-SA-96-040; referenced in http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP05-19_LitReview.pdf

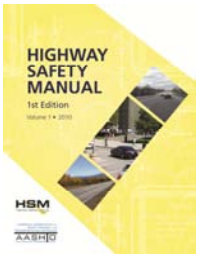
Intended Outcomes

Goal - Develop a risk-based approach to reduce roadway lighting to the **fullest extent possible** without significant impact to **crashes** and mobility

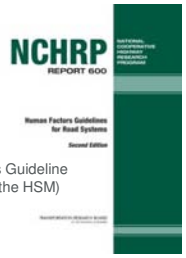
- **Sustainable and Clean Technology**
  - Governor Inslee's Executive Order 14-04: Washington Carbon Pollution Reduction and Clean Energy Action
  - Reduced greenhouse gas emissions from electrical energy consumption
- **Reduce Life Cycle Cost**
  - Provide light only when needed (existing and future systems)
  - Then, Convert to high – efficiency LED technology

ILLUMINATION REFORM RETHINKING WHY WE LIGHT

Tools & analysis methods



Predictive methods in Part C of the Highway Safety Manual



Human Factors Guideline (companion to the HSM)

•AASHTOWare SafetyAnalyst network screening (using Part B methods of the Highway Safety Manual)

Domestic & International Illumination Research Review

- >300 papers & reports (1960's – 2014)
- Rigor of research methods evaluated based on:

Experimental design
- Site selection: were the sites similar in characteristics or different? What criteria were used?
- Which crashes were included in the analysis? How were they identified?

Datasets
- Sample size: how many crashes were analyzed and what are the confidence levels for the results?
- What site characteristics were collected and included in the analysis?

Analysis method
- Is the method science-based and valid for crash analysis?
- Are the assumptions scientifically sound?
- Did the method account for differences in roadway characteristics that we know have impact on crash performance?

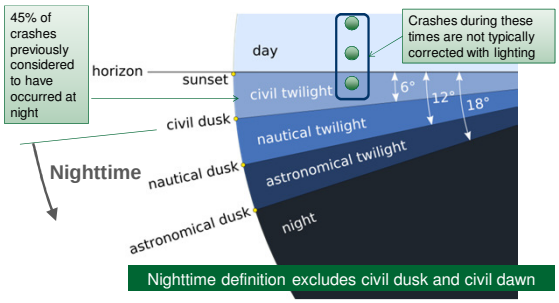
Domestic & International Illumination Research Review

- Published research from 2010 – 2014
  - Some research includes consideration of other factors that may impact crash risk and severity:
    - Geometry / Channelization
    - Speed
    - Traffic Volume
    - Congestion
    - Pavement Markings
    - Access Density
- Published research prior to 2010
  - Before / After Crash analysis is suspect to *"apples and oranges"* type issues
    - Why one location has lighting and another does not (geometric/ context-specific characteristics)
    - Ratios for daytime: nighttime crash rates– basis for assumptions for this method questioned based on current safety science

In recent years: changes in computing power and analysis methods

- What previously required a large mainframe system, can now be done on a basic PC – combining data, analysis methods etc.
- Datasets on roadways, traffic volumes, crashes, and assets can be more easily combined
- Crash reduction predictive methods have improved significantly
  - It can take multiple factors into account (geometry, flow, and context)
  - Robust modeling techniques have been proven valid for crash analysis
- Robust modeling approaches can help us understand
  - How much lighting impacts crashes at nighttime
  - Where would lighting reduce crashes at nighttime
  - Where may lighting have an adverse impact on crashes at nighttime/ during the daytime?

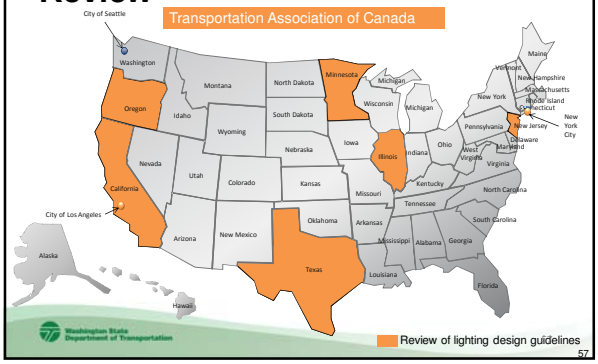
How do we define nighttime?



Nighttime definition excludes civil dusk and civil dawn

Domestic State Design Manual Review

Transportation Association of Canada



Review of lighting design guidelines

How are states deciding on illumination?

Criteria/ warrants:

- roadway related criteria (functional class, interchange spacing, adjacent roadway lighting and land development, crossroad spacing, cross-section elements, pavement classifications,);
- Engineering judgment
- Crash Reduction-based
  - **Night-to-day crash rate ratio** (thresholds may vary across functional class and other characteristics)
  - Analysis (only some cases, mostly not required, others require analysis to demonstrate that the installation will reduce crashes or crash risk)
  - Engineering judgment
  - decision-making points or points deemed as having high nighttime crash risk
  - **Crash reduction based warrants are sometimes not part of illumination manuals**/ design manuals used for illumination selection & design.

Guidance documents:

- IES
- AASHTO
- TAC
- NCHRP Report No. 152 Warrants for Highway Lighting

Lighting requirements:

General: Often numerous categories of facility types and contexts - contexts are often vague and open to engineering judgment (not necessarily conducive to statewide consistent application)

1. **Luminance/ lighting levels** – **vary greatly even when the same guidance documents are used for references** (sometimes small incremental changes across facility types and context that would have significant impact on the cost of the lighting installation)
2. **Uniformity**: **varies from 3:1 to 6.5** (often regardless of guidance document the manual is based on)

How are states deciding on illumination?

In General Terms

Typical Triggers lighting

1. More Light and lower Uniformity are better
2. Night time congestion is a trigger for continuous illumination
3. Complex Roadway Geometry (closely spaced interchanges, weaving)
4. High night time ADT
5. Urban Area / Nearby Commercial or Ambient Lighting
6. Assumption that night crashes are always mitigated with illumination
   - **Use of day / night crash frequencies in crash reduction warrants**

A preconceived notion that lighting saves the day…

- Deeply held beliefs:
  - Roadway lighting reduces crashes during dawn and dusk (civil twilight)
  - All nighttime crashes can be 'fixed' with roadway lighting
  - The ratio of daytime vs nighttime crash rates is a reliable and science-based method to estimate how many nighttime crashes to expect at a given location
  - During congested conditions, adding roadway lighting reduces crashes
  - Nighttime crash rates is a reliable and science-based method to identify locations for lighting
  - Just a few years of crash history are needed to identify locations where roadway lighting will reduce crashes
  - Roadway lighting reduces crashes at the daytime
  - More uniform light is better
  - Roadway complexity is always a trigger for illumination

A preconceived notion that lighting saves the day…

A new perspective on some deeply held beliefs:

- ~~Roadway lighting reduces crashes during **dawn and dusk** (civil twilight)~~ crash reduction is unlikely during civil twilight because there is still sufficient small target visibility at that time
- ~~All nighttime crashes can be 'fixed' with roadway lighting –~~ only a subset of nighttime crashes may be 'correctable' with illumination
- ~~The **ratio of daytime vs nighttime crash rates** is a reliable and science-based method to estimate how many nighttime crashes to expect at a given location –~~ *scientific basis uncertain*
- ~~During congested conditions, adding roadway lighting reduces crashes –~~ no scientific basis found & vehicle headlights add lighting during nighttime congested conditions
- ~~**Nighttime crash rates is a reliable and science-based method** to identify locations for lighting –~~ a crash rate is not a reliable method for identifying potential locations for lighting
- ~~**Just a few years of crash history** are needed to identify locations where roadway lighting will reduce crashes –~~ crashes are random & our methods should account for the variation; the methods should also account simultaneously for other factors at the location that are likely to impact crash risk.
- ~~Roadway lighting reduces crashes at the daytime~~ – research review found no scientific basis for the assumption that lighting would reduce crashes during daytime (i.e. lighting conditions other than dusk to dawn)
- ~~**More Uniform Light is better** –~~ *scientific basis uncertain*
- ~~**Roadway complexity is always a trigger** for illumination –~~ *scientific basis uncertain*

- **The cost of replacing lighting poles that are hit is large ($750k annually) & presence of poles create crash risk**

WSDOT Design Policy Changes – July 2014

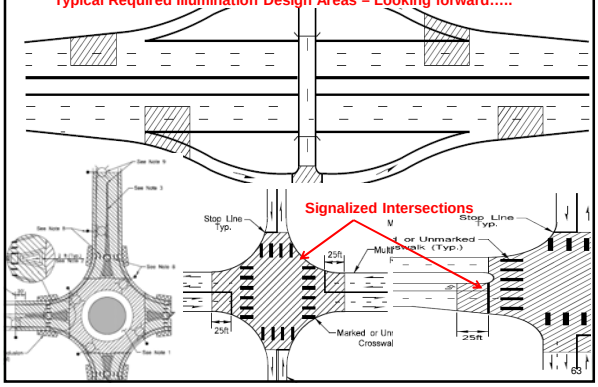
In general terms:

- Illumination is either **required at specific locations all the time** or **added based on "Other" context**. (Cash Reduction, Pedestrian Security, Economic Vitality, etc.)
- For Crash Reduction based additional illumination a Crash Analysis is required.
  - 5 years crash history
  - Must have a B/C greater than 1
  - Must consider alternative lower cost counter measures first
- Note: Planning to remove the requirement for overhead sign lighting

WSDOT Design Policy Changes – July 2014

In general terms:

Typical Required Illumination Design Areas – Looking forward…..



WSDOT Design Policy Changes – July 2014

In general terms:

- **Use of LED and Adaptive Lighting are allowed**
- All 3:1 Uniformity requirements moved to **4:1**
- Consolidated Highway Design Classes

Light Level and Uniformity Ratio Chart

Highway Design Class	Minimum Average Maintained Horizontal Light Level[2] – Pedestrian/Area Classification: High (footcandles)	Medium (footcandles)	Low (footcandles)	Maximum Uniformity Ratio[3][4]	Maximum Veiling Luminance Ratio[5]
Highways With Full Access Control[1][2][3]					
Main Line	0.6	0.6	0.6	4:1	0.3:1
Ramps	0.6	0.6	0.6	4:1	0.3:1
Crossroads	0.6	0.6	0.6	4:1	0.3:1
Ramp Intersections	0.9	0.9	0.9	4:1	0.3:1
Highways Without Full Access Control[1][2][3]					
Main Line	1.2	0.9	0.6	4:1	0.3:1
Intersections	1.2	0.9	0.9	4:1	0.3:1
Other Illuminated Features					
Construction Lanes and Detours	1.0	1.0	1.0	4:1	0.3:1
Major Parking Lots/Rest Areas	0.8	0.8	0.8	4:1	0.3:1
Vehicle Inspection Areas	2.0	2.0	2.0	4:1	0.3:1
Sidewalks, Walkways & Shared Use Paths	0.8	0.8	0.8	4:1	0.3:1
Weigh Scales	0.8	0.8	0.8	4:1	0.3:1
Transit Stops[6]	2.0	2.0	2.0	NA[6]	0.3:1
Midblock Ped X-ing	2.0	2.0	2.0	4:1	0.3:1

Illumination Reform

Accomplishments

- 33+ LED projects are planned, underway or completed
  - 1,100+ LED Lights installed with 1,600+ additional planned LED Light conversions
- US 101 in Olympia - Adaptive Roadway Lighting Pilot (Operational Dec. 2013)
  - 74% Energy Reduction, 2,100 MTCO2e reduction over 15 years
- Design Policy Revisions, (Implemented July 2014)
  - Domestic and International lighting research review
  - Domestic state design policy review
  - Robust state-of-the-art predictive modelling per the AASHTO Highway Safety Manual and NCHRP Human Factors research
- Received $500k Department of Commerce Energy Efficiency Grant (Dec. 2014)
- Asset Management – Completed Interstate mainline crash analysis to identify lights that could be removed.
- Developed new procurement contracts and a products evaluation process to assess and adopt new technology

Illumination Reform

Looking Forward

- Crash analysis for all State Route mainline roadways
  - Develop GIS Map indicating where lights are needed and where they can be removed
- Performance Contracting
  - $2M LED Roadway Lighting Conversion Project is underway using the Department of Enterprise Services Energy Savings Performance Contracting Process
- Additional Research
  - SHRP2 Naturalistic Driving, $100k Grant
- Communication plan
  - Discussing conversion to LED technology and light removal projects
- LED Technology and adaptive lighting control systems are approved for use

Credits: WSDOT Illumination Reform and LED Adaptive Roadway Lighting

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Energy Savings Performance Contracting

Presented by: Doug Kilpatrick, P.E.

June 3, 2015

Washington State Department of Enterprise Services

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ESPC Definition

- A method of identifying, constructing and financing energy and utility conservation projects
- Uses energy and utility dollars saved to pay for the project costs
- Eliminates most of the risks associated with the design, bid, build (DBB) process

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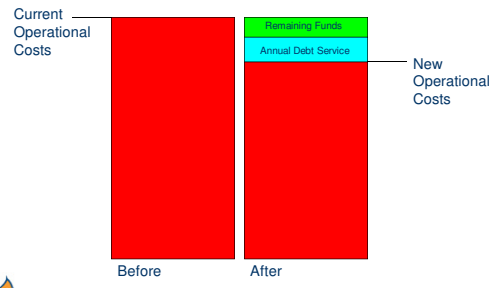
Paying for Project Costs

A Budget Neutral Approach



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Legislative Authority

RCW 39.35A.050

– The state department of enterprise services shall maintain a registry of energy service contractors and provide assistance in identifying available performance-based contracting services

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Legislative Authority

RCW 39.35C.020(2)

- The department shall assist state agencies and school districts in identifying, evaluating, and implementing cost-effective conservation projects at their facilities (to include) providing technical and analytical support, including procurement of performance-based contracting services

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ESPC Benefits

- Owner involved with contractor and equipment selection
- Low bid acceptance is not required
- DES has over 25 years of successful performance contracting experience
- Maintenance costs are reduced
- Positive cash flow over the measure life
- Funding available through the State Treasurer

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ESPC Guarantees

- **Maximum project cost** – no change orders unless authorized by the owner
- **Minimum energy savings** – Measurement and Verification of savings is included in the contract
- **Equipment performance** – Measures must provide the comfort and utility expected

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Qualifying Project Types

Energy, Water and Sewer saving projects such as:

- Lighting projects – lamps, ballasts & fixtures
- HVAC modifications
- Steam & condensate piping systems
- Boiler & chiller systems
- Energy management control systems
- Buildings and grounds water conservation

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DES Experience

- **Working in public facilities since 1986:**
  - Completed in excess of $500 million dollars in performance contracts
  - Satisfied clients in over 400 public facilities
  - Saved over 240 million kWh and 14 million therms
  - Clients received over $42M in utility incentives
  - Annual cost avoidance savings of $30M
  - Currently managing over 200 projects and $270M in construction due to stimulus grants

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Thank You

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Break Time

http://rt.com/usa/191480-california-dogs-surfing-competition/

10 minutes

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Governor's Executive Order 14-04 (Washington Carbon Pollution Reduction and Clean Energy Action)

Tony Usibelli, Assistant Director and
Chuck Murray, Senior Energy Policy Specialist,
Washington State Energy Office at Washington State Department of Commerce

June 3, 2015

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Energy Efficiency Actions in the EO

- Provide businesses and homeowners with access to energy use, efficiency, and cost information such as building energy efficiency disclosure requirements and other means;
- Improve access to financing for energy-efficiency upgrades, including meter-based financing that ties efficiency investment to the building;
- Support vulnerable and low-income populations through weatherization assistance, setting minimum standards for rental housing energy efficiency, and securing funding for energy efficiency for non-utility fuel sources such as oil heat;
- Achieve early and widespread deployment of energy-neutral buildings prior to the 2031 statutory requirement in RCW 19.27A.160;
- **Upgrade the energy efficiency of all street lighting within the state;** and
- Ensure that the cost-benefit tests for energy-efficiency improvements include full accounting for the external costs of greenhouse gas emissions.

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Street and Roadway Lighting

Parameter	Sixth Plan	Seventh Plan (draft)
Unit Savings at busbar (kWh)	190 to 280	340 to 3200
Levelized Cost ($/MWh)	3 to 250 73 weighted average	(-100) to 16 (-39) weighted average
Levelized Cost ($/MWh) Without maintenance savings	NA	(-5) to 34 18 weighted average
Baseline EE Saturation	<1%	22% by end 2015*
Number of Units (20 years)	1.5 million	1.3 million
Achievable Technical Potential (aMW over 20 years)	44 aMW	55 aMW

* Updated: Was 13%

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Northwest Power and Conservation Council

Exterior Building Lighting

Parameter	Sixth Plan	Seventh Plan (draft)
Savings per Unit	30% 1 measure	50% to 80% 8 measures by applic & size
Levelized Cost ($/MWh)	$33	$<0 to $10
Levelized Cost ($/MWh) (No NEB)		$<0 to $65
Baseline EE Saturation	Parking 1% Exterior 1%	Parking 30% Exterior 25%
Applicability	30%	70% More options on market
Number of Units (20 years)		New estimate of units from CBSA 2014
Achievable Technical Potential (aMW over 20 years)	142 aMW	147 aMW

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Northwest Power and Conservation Council

Embedded Parking Garage Lighting

- Embedded: Included inside a building
  - About 6% of building floor area, most in office buildings
  - Measure: HID to LED with step dimming
  - Fraction HID per CBSA (~40%)
  - LED saturation 4% of fixtures
  - About 20% with occupancy sensor
  - No measure for fluorescent
  - Total use about 70 aMW
  - Savings potential <20 aMW
- No data for count of dedicated parking structure
  - Only 1 in CBSA – So potential estimate is partial

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Northwest Power and Conservation Council

Commercial Lighting Measures

Total Achievable Potential Available by Year (aMW)

Commercial	2020 aMW	2025 aMW	2035 aMW	TRC Lvl Cost ($/MWh)
Lighting	196	**448**	711	**17**
LPD Package	102	208	391	13
Low Power LF Lamps	11	35	40	24
Lighting Controls Interior	5	14	37	130
Exterior Building Lighting	46	118	142	12
Street and Roadway Lighting	24	53	61	-34
Parking Lighting	5	8	8	25
Bi-Level Stairwell Lighting	1	4	11	79
LEC Exit Sign	3	8	19	13

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April 2015

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Energy Efficiency and Solar Grant Program

Presented by: Pat Gibbon and Tom Stilz

June 3, 2015

86

Background and Program Purpose

- Grants are awarded through a competitive process
- Grants may be used solely for energy and operational cost savings improvements
- Immediate program goal is to stimulate Washington's economy by creating jobs
- Long-term goal - reduce energy costs at state and local government agencies and public higher education facilities

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Grant Scoring Criteria

Grants will be awarded through a competitive process, based on the following criteria and scored in the following order:

Leverage ratio (the higher the ratio of non-state funds to state funds, the higher the score)

Energy savings (the higher the energy savings, the higher the score)

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What Funds Can Be Used for Non-State Leverage?

Local Governments may use the following non-state funds as leverage/match:

- Local Option Capital Asset Lending (LOCAL)
  through the Office of the State Treasurer
- Utility incentives
- Private lenders
- Local and federal funds
- Non-state appropriated funds

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What Funds Cannot be Used as Leverage

Any funds that originated as an appropriation from the Legislature.

These funds cannot be used to supplant other funds obtained through the private sector – e.g. payoff loans)

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Energy Efficiency and Solar Grant Program For Local Governments, State Agencies and Higher Education

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June 3, 2015

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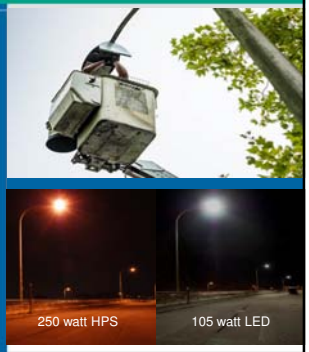
The Role of An Energy Services Company In LED Conversions: Bringing it All Together

Washington Transportation Professionals Forum
June 3, 2015

Fritz Feiten
Manager, Business Development
Ameresco



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Presentation Agenda

- Quick note on terminology
- Ameresco overview
- Benefits of using an Energy Savings Performance Contract for LED street light conversions
- Examples of how Energy Services Companies "bring it all together" for LED street light conversions

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Terminology

- ESPC = Energy Savings Performance Contract
  - A public procurement approach used to identify, implement and finance infrastructure improvements that save energy and leverage utility rebates, grants, and capital dollars or loans to maximize benefits
- ESCO = Energy Services Company
- Through an ESPC the ESCO:
  - Performs energy audits,
  - Identifies resource & operational savings opportunities,
  - Designs infrastructure improvements that reduce resource consumption and maintenance costs,
  - Implements the improvements as the general contractor,
  - Provides a guaranteed not-to-exceed cost
  - Guarantees the energy savings

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About Ameresco

- One of the largest ESCOs in North America
- Focus on energy efficiency and renewable energy
- Completed over $5 billion in projects to date
- Extensive street light experience
  - First city-wide LED conversion in WA (Longview, 2010)
  - 12 muni projects completed or underway in WA, including Longview, Renton, Olympia, Everett, Lakewood, Kent, West Richland, Kelso, etc. plus many more across the US
  - First large-scale LED deployment for WSDOT (2015)
  - Secured over $4M in Commerce grants for street light projects to date
  - First control-based utility billing agreement in US (West Richland/BREA)
  - Largest street light project to date: Henderson, NV (28,000 lights)
  - Recent awards: Tucson, AZ (23,000 lights), E. Hartford, CT (6,000 lights)
  - Current projects in development (US & Canada): >250,000 lights

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ESPC Benefits for LED Street Light Conversions

- ESCO Expertise
  - Street light projects are more complicated than they may appear
  - Audit, luminaire selection, design, installation, warranty from one vendor
- Rapid, Turnkey Execution
  - Time is money with 50-60% savings on the line
- Luminaire Choice
  - You get the luminaire you really want, low bid not required
- Guaranteed Outcomes
  - Guaranteed not-to-exceed project cost & energy savings
  - Extended labor warranty available
- Lower Overall Project Cost
  - ESCO luminaire buying power
  - Installation bid to multiple qualified sub-contractors
  - Rapid installation to begin capturing savings ASAP

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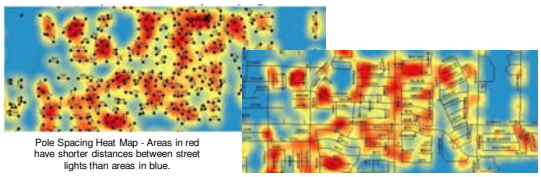
State of the Art GIS Audits

- Do you know how many street lights you own, where they are, and the characteristics of each pole, arm and luminaire?
- Your ESCO should have experience with street light audits that:
  - Utilize existing data (boundary maps, inventory, GIS data, etc.)
  - Confirm or capture geo location and other data for every street light
  - Enable rapid updating of luminaire data during the LED conversion
  - Provide a complete, accurate inventory of your street lights and their characteristics, including pole spacing
  - Accomplish all this efficiently and at minimal cost

3 poles on east side of red line are outside the city boundary

Lighting Design

- The ESCO can provide:
  - Design and photometric analysis that consider road classifications, pole spacing, mounting height, arm length and curb setback
  - Hybrid designs that meet RP-8 or other design practices in most areas, and achieve same or better light levels in areas where that is not possible
  - Designs that use the right luminaire for each application to minimize initial cost and maximize energy savings



Pole Spacing Heat Map - Areas in red have shorter distances between street lights than areas in blue.

LED Luminaire Selection

- ESCOs are product neutral – you set the selection criteria, you choose the luminaire
- Your ESCO will help with pricing, samples and trial installations
- Low bid is not required for an ESPC
  - Lowest first cost is not always the best choice
  - Specification-based selections can also be problematic because products improve rapidly and specifications become outdated quickly
  - Your ESCO can help you choose the luminaire that provides the features you need at the lowest lifecycle cost available today

Energy Savings Calculations

- ESCO will calculate pre- and post-conversion energy use and guarantee the energy savings
- ESCO will determine how the energy savings impacted by available tariffs
  - Can all the kWh savings be turned into $ savings?
- What about street light controls?
  - What are the energy savings implications of dimming strategies, such as trimming, scheduled dimming, or constant light output?
  - Can dimming savings be monetized today? In the future?
  - Can an unmetered system be converted to a metered rate structure with controls that offer metering? Yes, in West Richland, WA

Maximizing Utility Rebates & Grants

- ESCO will calculate and process utility rebates
  - Will the utility provide rebates for controls? Yes, depending on your utility
- ESCO will help you develop the best strategy to secure a Commerce energy efficiency grant
  - Should the LED street light conversion be packaged with other energy efficiency measures?
  - What leverage ratio is needed?

Financing Street Light Projects

Your ESCO will help identify cost-effective internal and external financing sources or will finance your project directly.

Thank You! Questions?

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State Lease Purchase & Local Program

Wendy Kancianich – Debt Administrator
Office of the State Treasurer

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Low Cost Financing for LED conversions & other Energy Savings equipment

- The Lease/Purchase Program provides state and local agencies with an alternative way to finance essential real estate and equipment over a multi-year period.
- Low cost financing is achieved through pooling funding needs into larger offerings of Certificates of Participation (COPs).
- Agencies benefit from economies of scale and the State's low tax-exempt financing rates.
- RCW 39.94 requires state agencies to utilize the Lease Purchase Program to finance equipment or real estate.
- Local Governments have the option of using the LOCAL Program for financing subject to existing debt limitations and financial considerations.

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Lease Purchase Requirements

- Proceeds of financing contracts must be spent on capital expenditures, in accordance with state accounting guidelines and under federal tax laws applicable to tax-exempt obligations.
- COP financings are for tangible physical assets that could be relinquished for non payment.
- The minimum size for each financing is $10,000.
- The maximum term of energy equipment financing contracts is set by the expected useful life table provided by the Office of Financial Management's State Administrative & Accounting Manual (SAAM), Chapter 30.50.

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Lease Purchase Requirements

- Funding is generally available twice a year in late summer/fall and spring.
- State Real Estate projects require legislative authorization. This would include a remodel, acquisition, or construction project.
- Agencies are required to submit a Notice of Intent prior to paying for the project/equipment.
- Debt service is due twice a year in June and December.
- Bond proceeds must be spent within 18 months of the closing date in order to comply with IRS tax exempt bond issuance requirements.

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Where to find more information

- http://www.tre.wa.gov/
- Lease Purchase Program; State Lease Purchase Program Guide, Finance Documents, Interest Rates
- Local Program – FAQ'S, checklist, Interest Rates
- Wendy Kancianich – 360-902-9022
- Wendy.kancianich@tre.wa.gov

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IntoLight

PSE Lighting Services

Tony Daniels
Account Manager, PSE Lighting Services
Kitsap, Thurston & Pierce Counties

June 3, 2015

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IntoLight is the lighting service of Puget Sound Energy that provides Sales, Engineering, Maintenance and Billing for Flat-Rate PSE owned & maintained Street Lighting.

Our rates are filed with the Utilities Commission by the Rates and Regulation Department.

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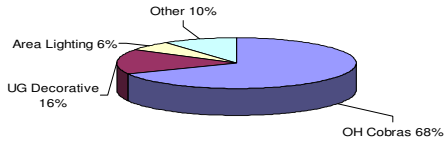
Street Lighting by Types



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MAINTENANCE

Corrective Maintenance:

- 3 – day maintenance guarantee or customer does not pay for the energy for the month.
- Reliant on PSE Access Center to enter outage reports immediately to ensure quick repair.
- 99.8% of all service calls are completed within 3 days.

Preventative Maintenance:

- 4 year Lamp replacement
- 8 year Photocell replacement.
- Preventative Maintenance reduces the number of corrective calls.

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Website, Outage Reporting & INTOLIGHT Tags

The customer can report outages in several ways:

Calling the PSE Access Center on the 1-888-CALLPSE.

Using the PSE website: www.intolight.com

E-mail, fax or call anyone in the street lighting department.

All PSE street lights are tagged with a unique 4-letter and 4-numbered designator. This designator is part of the GPS system.

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GPS PROGRAM

- Data can be shared with customers. In the form of:
  - A printed list
  - Maps
  - Electronic data files
- Excellent customer service to Cities & Government agencies. 1-2 day services.

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Why Use LED?

- Reduce Maintenance
- Save Energy
- Better Neighbor (Optical Control)
- Improved Visibility
- Safety
- Environmentally Conscientious

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Completed LED Change Outs

- Redmond
- Olympia
- Woodinville
- Sedro-Woolley
- Buckley
- La Conner
- Nooksack
- Coupeville

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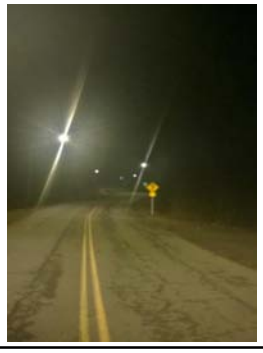
LED Change Outs in process

- Bellevue
- Sumner
- Mount Vernon
- Anacortes
- Des Moines



117

PSE currently uses GE Evolve Roadway Cobrahead

More information can be found at:
http://www.gelighting.com/LightingWeb/na/solutions/outdoor-lighting/roadway/evolve-led-specification-grade-scalable-cobrahead.jsp

118

Decorative LED Installations

City of Bonney Lake
Main St.

Product used –
King K56 LED Post Top Fixture

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PSE owned & maintained Incentive Rebate for approved LED fixtures

< or = 50W = $40
51W – 75W = $40
76W – 100W = $60
101W – 150W = $70
151W – 200W = $100
200W+ = $100

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Customer owned incentive program & rebate

- Customer or contractor submits a signed PSE Business Lighting Workbook and cutsheets for proposed light fixtures to businesslighting@pse.com
- PSE engineer reviews the project application and schedules a pre-installation site visit.
- PSE engineer completes the project review and the project is approved for PSE funding, a Grant Agreement gets issued to customer.
- Customer proceeds with the project and notifies PSE engineer when it is completed. Final invoices will be collected at this time.

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Customer owned incentive program & rebate (cont.)

- PSE engineer conducts a final site visit to confirm that the project has completed in accordance with the original scope of work. Any discrepancies or changes could affect the final grant amount.
- Grant payment is issued.
- Our incentive structure for standard business lighting program is $0.2/kWh saved, up to 50% of the project cost.
- For more information please contact Dan Meyers, P.E., CEM at Danny.Meyers@pse.com or (360) 786-5934

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THANK YOU!

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Break Time

Nipclub.blogspot.com

15 minutes

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Relight Washington

Presented by:
Steve Gorcester,
Executive Director

2015

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Problem Statement

- Need a statewide strategy to ensure inclusion of small cities.
- Usual TIB grant process too plodding for fast pace of street light installation.
- Small cities are the left-behinds.
- Initial capital prevents participation based on business case alone.
- Lacked empirical evidence to demonstrate savings to service providers.

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Unique Barriers

- Smalls don't own, but need the savings the most
- Add a pole
- Lighting design
- Low customer awareness
- Electric providers
  - Technology/maintenance acceptance
  - Not believing the savings
  - Willingness to impact profit center
  - Lack of uniform response across providers

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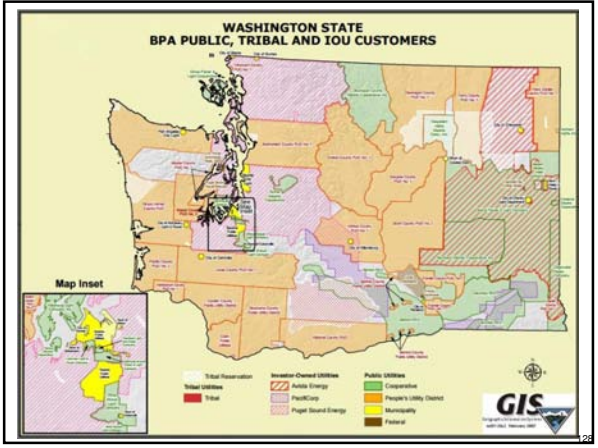

128

Buckley sets the scale

- $90,000/year direct distribution gas tax
- $55,000 to street lights (60 percent)
- 245 PSE Cobras
- City-owned parking lot lighting, no replacement parts
- City-owned decorative lighting

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TIB Business Need

- Include 165 small cities being left behind
- Determine if feasible to deliver savings to end customer
- Dilapidated condition of existing infrastructure
- Varying fixture types
- Add a pole problem
- Determine if the technology was really ready

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PDCA

- Could have just started street light grant program
- Would have been a mess
- Providers not required share savings with customer (no rate tariffs)
- Spotty, customer driven response
- Feasibility Study
- SROI Study
- Achieve Goals

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Street Lights in State Government

- Executive Order 14-04
- Other state initiatives
  - Commerce Energy Grants
  - DES ESCO Prequalification
    - Solves capitalization problem
    - Solves knowledge problem
    - Requires 7 year repayment with profit
    - Didn't solve small city problem because still blocked by the barriers
  - WSDOT State Route Lighting

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Early Results

- SROI $2.34 in savings per $1.00 over 15 years
- Buckley saving 26%
- Benton City saving 55%
- Blaine energy usage down by 50-66%

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Going Forward

- Governor priority
- TIB Funding decision
- Puget Sound Energy
- Avista Utilities
- 2015 objective: operationalize investor-owned partnership
- TIB grants for other cities

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Expected Program Costs

Customer group	# of Agencies	Est. Lights	Est. Cost	Required Budget
Small Cities only	160	32,000	$14m	$3m
$1 billion A/V	36	70,000	$25m	$8m
$2 billion A/V	30	50,000	$17m	$12m

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Transportation Improvement Board
Contact

Steve Gorcester
Executive Director
(360) 586-1139
steveg@tib.wa.gov
www.tib.wa.gov
www.tib.wa.gov/tibdashboard

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CITY OF OLYMPIA
LED Streetlight Conversion

Washington Transportation Professionals Forum
June 3, 2015

Presented by:
Mark Russell, P.E.
Director of Transportation
Public Works Department

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LED Streetlight Conversion

The Problem

- 4,500 Streetlights
  - 3,200 City-owned lights
  - 1,300 owned by Puget Sound Energy
- End of useful life
- Rising failure rate
- Maintenance challenge

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Downtown

- City owned
- PSE owned

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Westside

- City owned
- PSE owned

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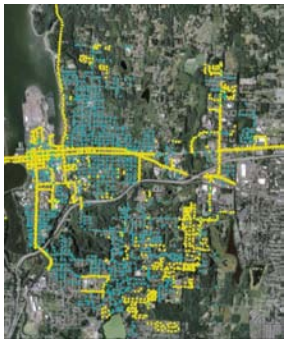
Northeast and Southeast



- City owned
- PSE owned

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Implementing the Conversion

3,200 City-owned Streetlights First

- Department of Enterprise Services
  - Energy Savings Performance Contract
- Combined with facility mechanical system improvements
  - The Olympia Center
  - Olympia Timberland Library

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Funding City-owned Streetlights

Total Project Cost - $2.8 Million

• WA State Dept. of Commerce Energy Efficiency Grant	$500,000
• Puget Sound Energy Utility Incentive	$369,000
• Debt Financing (Bond)	$1,700,000
• City Capital Funds	$250,000



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Benefits to City

- Use 50 to 60% less energy
- $174,000 annual power savings
  - Payback in 10 years
- Guaranteed energy savings used to pay for streetlight upgrades
- Reduce carbon dioxide emissions
  - 1.85 million pounds annually
- Reduce maintenance costs
- Improve visibility and safety


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PSE Conversion Program

1,300 Streetlights – Project Cost $325,000

- Customer driven
- Rebates through Utility Incentive Program
- PSE completed work through *Intolight* and *Potelco*
- Benefits
  - Lower monthly rate schedule
  - Saves $60,000 per year
  - Payback in 5 years

INTOLIGHT

POTELCO INC

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Lessons Learned

- Unique contracting method – learning process
- Weaknesses in our streetlight system revealed
  - Fuses
  - Wiring
- City needed project staff assigned
  - Citizen inquiries
  - Technical questions
  - Administration
- Different type of light
  - Citizen expectations
  - Period of adjustment

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Questions

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Illumination Reform

Case study 3: WSDOT's LED Adaptive Lighting Pilot, US 101 in Olympia, WA

Keith Calais
Signal and Illumination Engineer
Washington State Department of Transportation

Ted Bailey, P.E.
Traffic Operations Business Manager
Washington State Department of Transportation

Washington Transportation Professionals Forum
Olympia, WA
June 3, 2015

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LED Adaptive roadway lighting pilot (US 101, Olympia WA)

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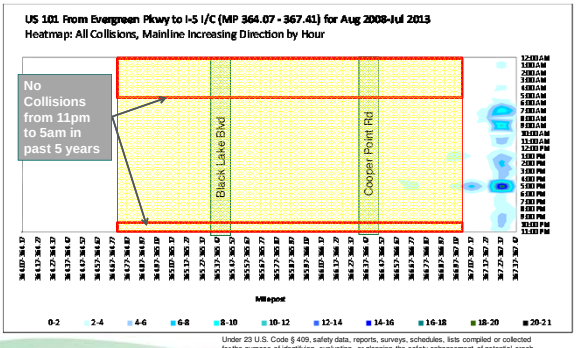
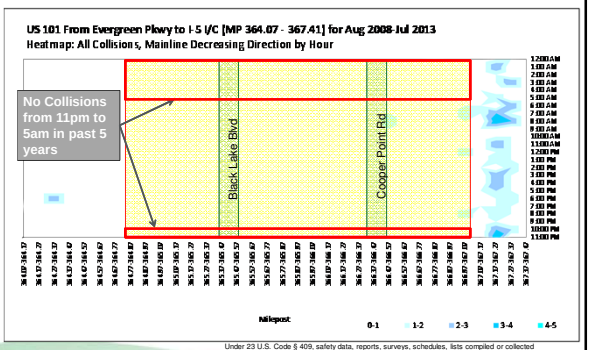
Crash Analysis – Eastbound US 101



150

Crash Analysis – Westbound US 101



Under 23 U.S. Code § 409, safety data, reports, surveys, schedules, lists compiled or collected for the purpose of identifying, evaluating, or planning the safety enhancement of potential crash sites, hazardous roadway conditions, or railway-highway crossings are not be subject to discovery or admitted into evidence in a Federal or State court proceeding or considered for other purposes in any action for damages arising from any occurrence at a location mentioned or addressed in such reports, surveys, schedules, lists, or data.

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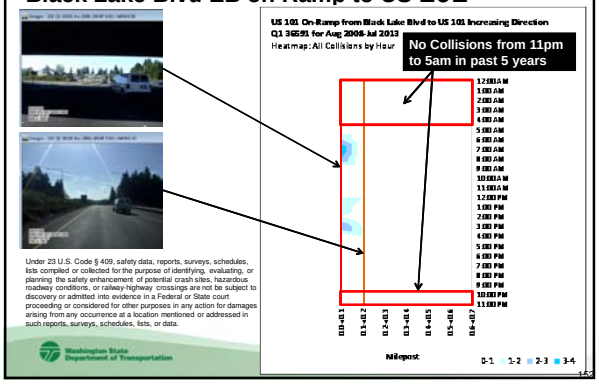
Crash Analysis – Black Lake Blvd EB on Ramp to US 101



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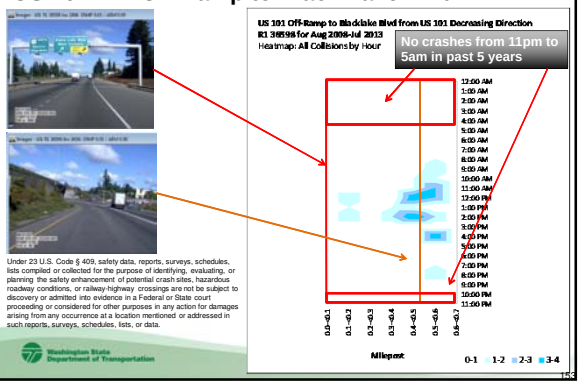
Crash Analysis – US 101 WB Off Ramp to Black Lake Blvd



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LED Adaptive System Installation (US 101 & Black Lake Blvd Interchange)

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LED Adaptive System Installation (US 101 & Black Lake Blvd Interchange)

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LED Adaptive Lighting – Phase 1 US101 & Black Lake Blvd Interchange Olympia, WA

Installed 88 LED Lights in April 2013

- 74% energy reduction or 1.7 M kwh over 15 years
- 1,200 Metric Tons of Carbon Dioxide Equivalent

Return on Investment
$174k Cost / $200k benefit over 15 year life cycle
= 13 Years

- Cost = $174k (Materials, Installation, Control Systems, Maintenance, Repairs)
- Benefit = $200k (Utility and Preventative Maintenance Savings over 15 years)

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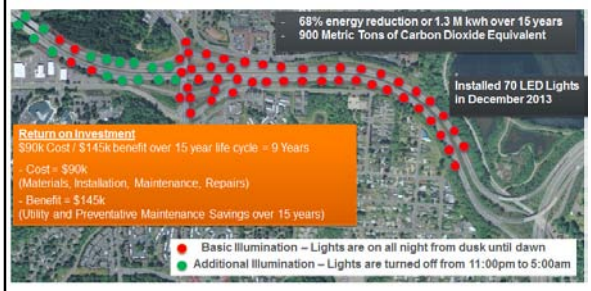
LED Adaptive Lighting - Phase 2
US101 & Copper Point Rd Interchange Olympia



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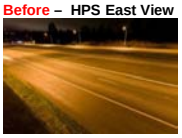
LED Adaptive Lighting – Phase 1
US101 & Black Lake Blvd Interchange Olympia, WA

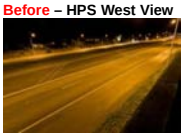
US 101 in Olympia: Adaptive Roadway Lighting Pilot (Black Lake Blvd)

Before – HPS East View



After – LED East View

Before – HPS West View



After – LED West View

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(US 101 & Black Lake Blvd Interchange) – Phase 1
Before / After Calculated Light Levels (Fc)

Objective: Average > 0.6 Fc; Minimum > 0.2Fc; Uniformity < 4:1

Westbound Off Ramp		310W HPS	185W LED
Priority Ramp	Average	1.24	0.84
	Maximum	2.4	1.6
	Minimum	0.4	0.3
Avg/Min (Uniformity Ratio)		3.10 : 1	2.80 : 1

Eastbound Off Ramp		310W HPS	185W LED
Priority Ramp	Average	1.23	0.86
	Maximum	2.5	1.7
	Minimum	0.3	0.2
Avg/Min (Uniformity Ratio)		4.10 : 1	4.30 : 1

Westbound Mainline	310W HPS	185W LED
Average	0.85	0.6
Maximum	2.7	2
Minimum	0.1	0.1
Avg/Min (Uniformity Ratio)	8.50 : 1	6.00 : 1

Eastbound Mainline	310W HPS	185W LED
Average	0.82	0.6
Maximum	2.7	1.8
Minimum	0.1	0.1
Avg/Min (Uniformity Ratio)	8.20 : 1	6.00 : 1

West Bound On Ramp	310W HPS	185W LED
Average	1.1	0.79
Maximum	2.6	1.8
Minimum	0.2	0.2
Avg/Min (Uniformity Ratio)	5.50 : 1	3.95 : 1

Eastbound On Ramp		310W HPS	185W LED
Priority Ramp	Average	1.21	0.82
	Maximum	2.4	1.6
	Minimum	0.2	0.2
Avg/Min (Uniformity Ratio)		6.05 : 1	4.10 : 1

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(US 101 & Black Lake Blvd Interchange) – Phase 1
Before / After Field Light Levels (Fc)

Source:
Dr. Ronald Gibbons,
Virginia Tech Transportation Institute

Calculated vs Field Measurements show this is not an exact science.

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Lessons Learned

Maintenance visited the project about a dozen times trouble shooting issues.

- Approximately 12 poles repeatedly blowing fuses.
  - High inrush current > 100 AMPS, switched to 20amp slow blow fuses
- 1 transformer had to be replaced.
- 1 bad driver in a fixture, works at half power.
- 1 bad fixture, keeps shorting out & blowing fuses.
- 13 Nodes would not connect.
- Several fixtures were delivered with wiring issues (Pinched, chaffed, bad insulation)

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Lessons Learned

- **Order Spares** – Fixtures and Control Nodes.
- **Polarity** of the circuit appears to make a difference – in both the head and node.
- Use **slow blow fuses** due to high inrush current
- LED fixtures are evolving rapidly so **expect some out of the box failures**.
- **Issues with using one main photocell** and communication with the nodes.
  - **Adds another step** in maintenance trouble shooting the system, they have to **log in to the Control System and turn all the lights on in addition to flipping the test bypass switch**.

– Public communication – Press Release was very beneficial
– Internal communication plan, briefing papers, lots of B/C analysis
– **Field Review with Executives**
– **Commissioning** – Purchase GPS nodes with the ability to connect to the gateway without having to manually enter MAC IDs – Huge potential for manual error

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Next Steps – Statewide Roadway Lighting Conversion / Removal / Adaptive Lighting Project

- LED Replacement
- Pole identified for removal
- Pole identified for removal (crash review recommended)

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Credits: WSDOT Illumination Reform and LED Adaptive Roadway Lighting

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Design Policy Review performed by:
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Post Doctoral Student
University of Washington

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Thank you and Goodbye

anglonubiangoatsociety.com

Next meeting:
Fall 2015 in Eastern WA

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