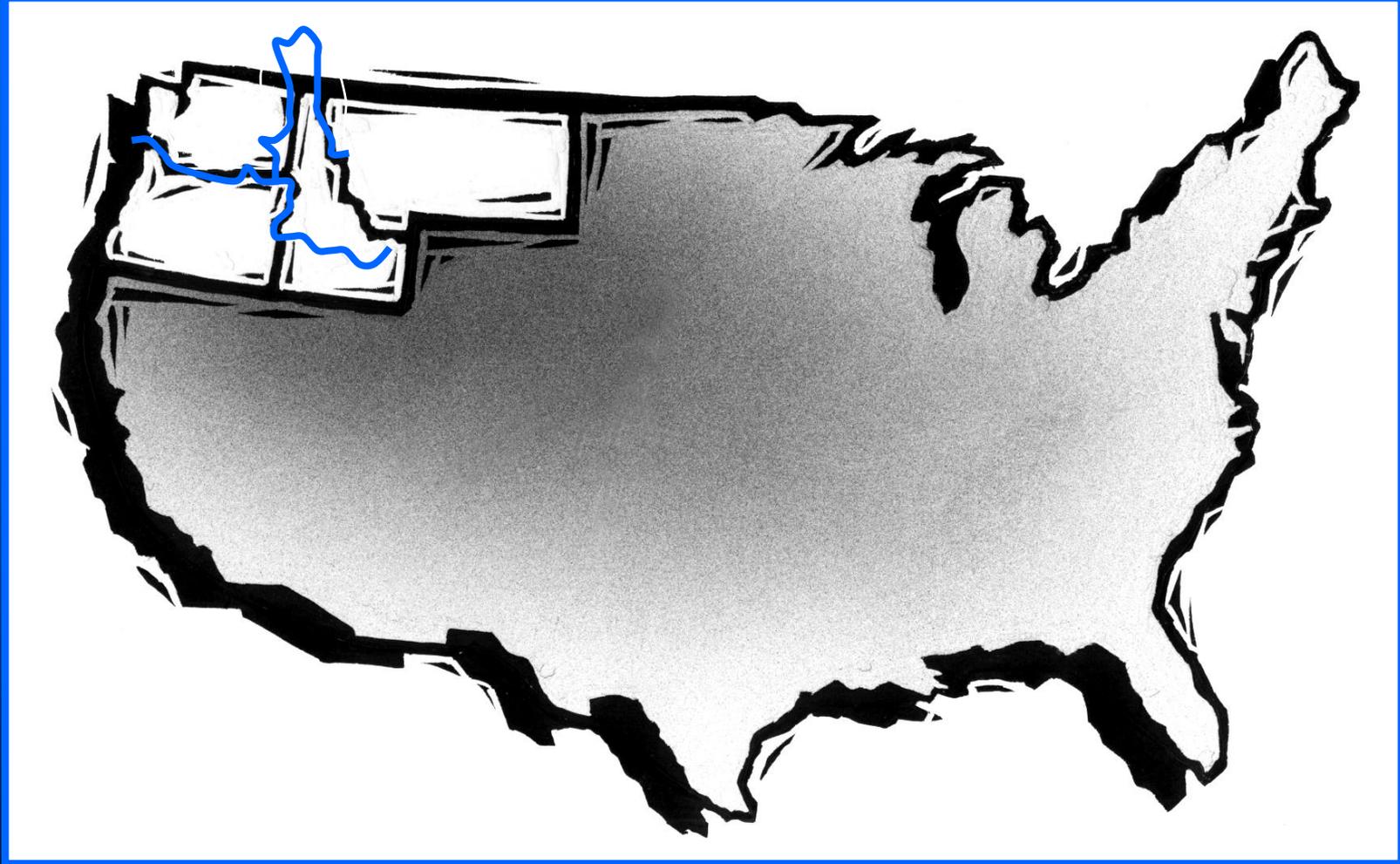


Balancing Risks and Rewards – The Economics of SSL

July 2008



The Pacific Northwest Region

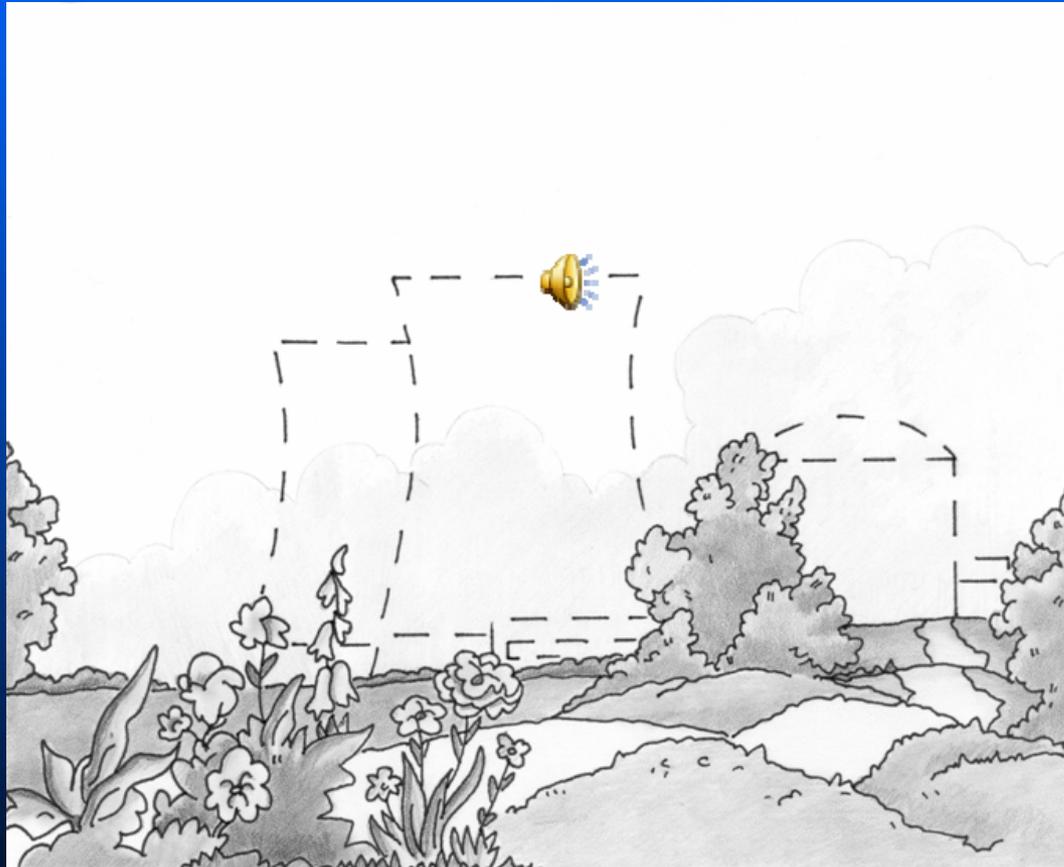


Economics

Electric Utility System Perspective

- A good investment for rate payer funds?
- TRC Perspective (Total Resource Cost)
 - Energy, Capacity, Line Loss Savings, Deferred T&D
 - Annual O&M costs or benefits
 - Periodic replacement costs or benefits
 - Space conditioning interactions
 - Quantifiable non-energy costs or benefits
 - Risk-mitigation benefit
- Metrics
 - Present Value of Benefits & Costs (TRC B/C Cost Ratio)

Conservation: The Stealth Power Plant



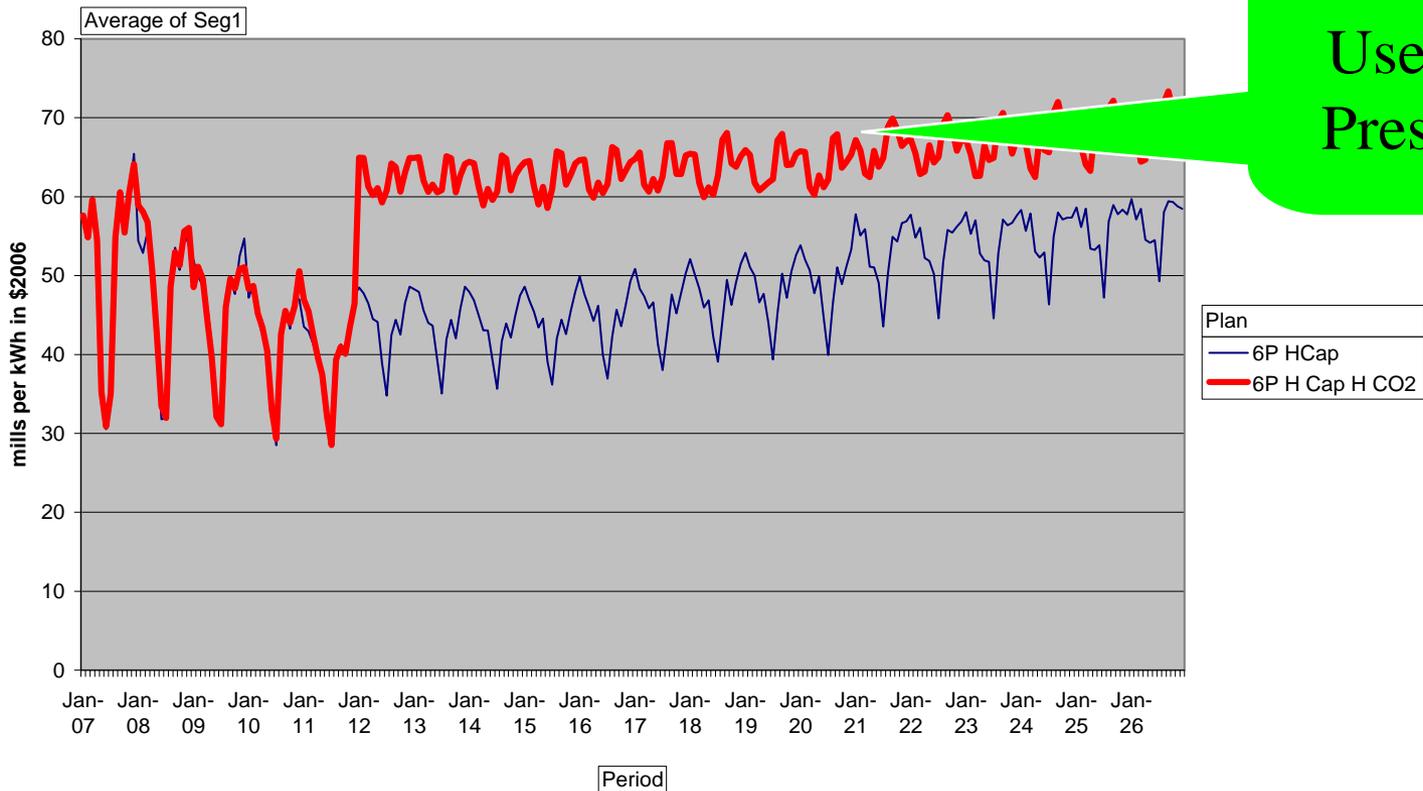
Caution: Your Mileage May Vary

- Wide range of costs & benefits
- Changing fast
- A work in progress



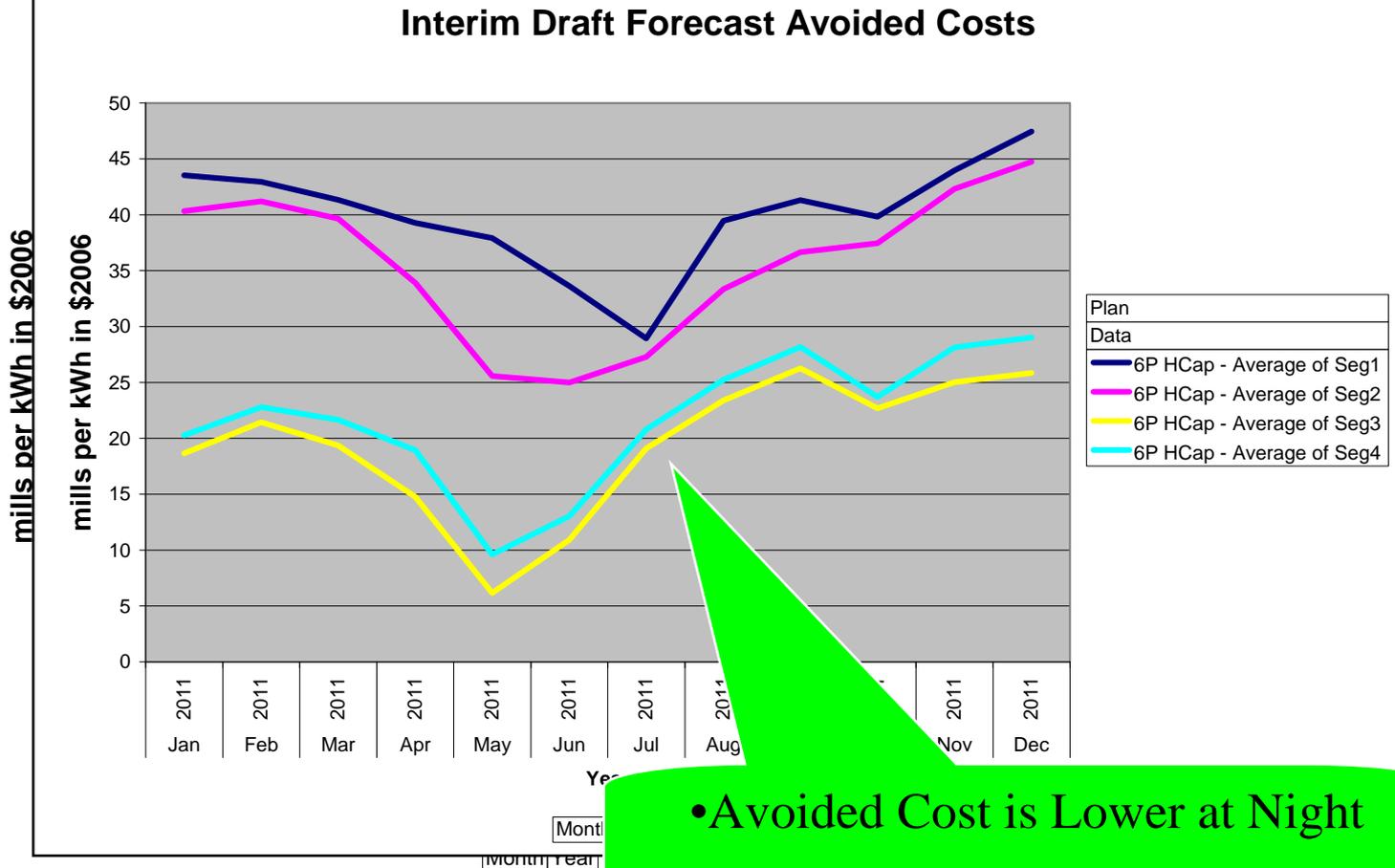
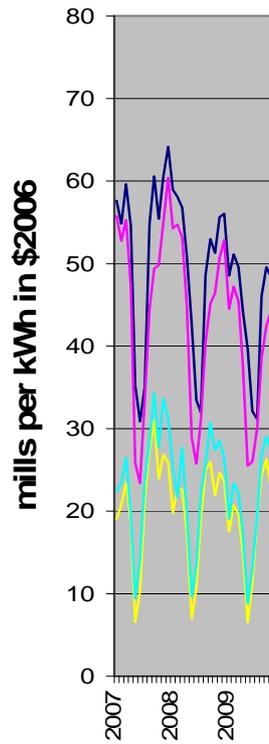
Key Inputs: *Avoided Costs*

With High CO2 Costs (\$43/ton CO2)



Avoided Costs
Used in this
Presentation

Key Inputs: Avoided Costs



• Avoided Cost is Lower at Night

Emerging Technology Considerations

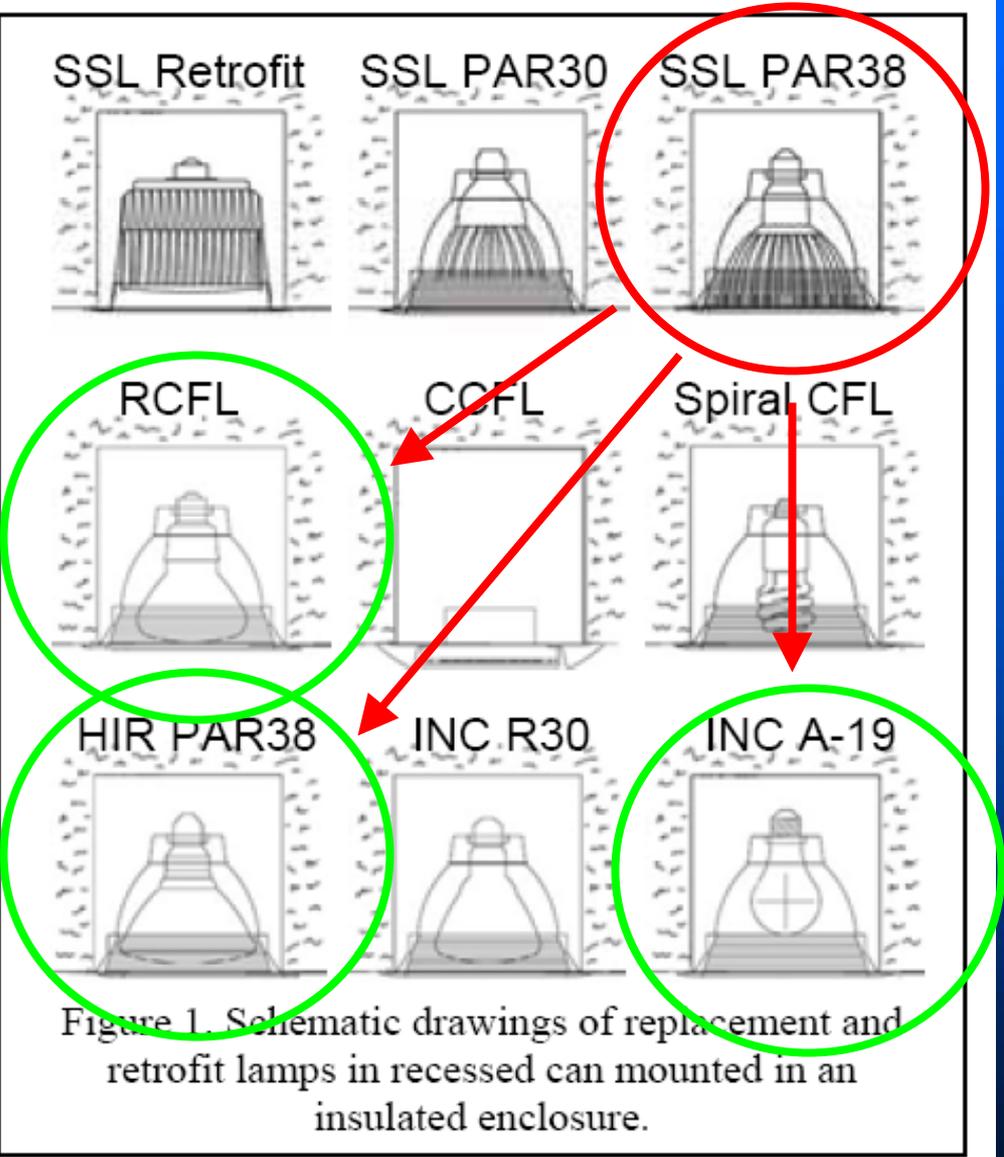
What Really Matters?

- Energy: What will it do to total energy use?
 - Lighting Power Density
 - Hours of Operation
 - Interactions with Heating & Cooling
 - Saturation of Lighting
- Customer: What will it do for me?
 - Color - Quality - Control - Lifetime

Emerging Technology Considerations

- What's the Baseline?
 - What does new technology replace?
 - Will the old technology improve?
 - Will the new technology increase saturation?

Downlights



•Primary Baseline

•Niche Baseline



Emerging Technology Considerations

■ Speed of Adoption?

– Stock turnover

» Retail Lighting – fast churn

» Street Lighting – slower

– Retrofit Penetration Rate

» Need big winners to penetrate markets fast

» Cost curves relative to baseline

Key Economic Considerations for SSL

- High First Cost
- Potentially Long Life
- Potential for More Useful Light
 - Designs are tunable for applications
 - » Directional, point sources, optics, color, life
- Potential for dimming & occupancy control
 - No warm-up or re-strike issues
 - Manageable color shift

Let's Look at Some Emerging SSL Products & Applications

- Outdoor Lighting
 - Street & Roadway
 - Walkway
 - Parking
 - Façade & Signage

- Refrigeration Display Case

- Recessed Can Downlight

- MR16 Replacements

- Desk Lamp / Task Lighting

- Undercabinet

- Good Applications
- Promising Economics
- New Potential MWh

- Compete with CFL (few new MWh)
- Some new MWh in Niches

- Room for Improvement

Outdoor Lighting



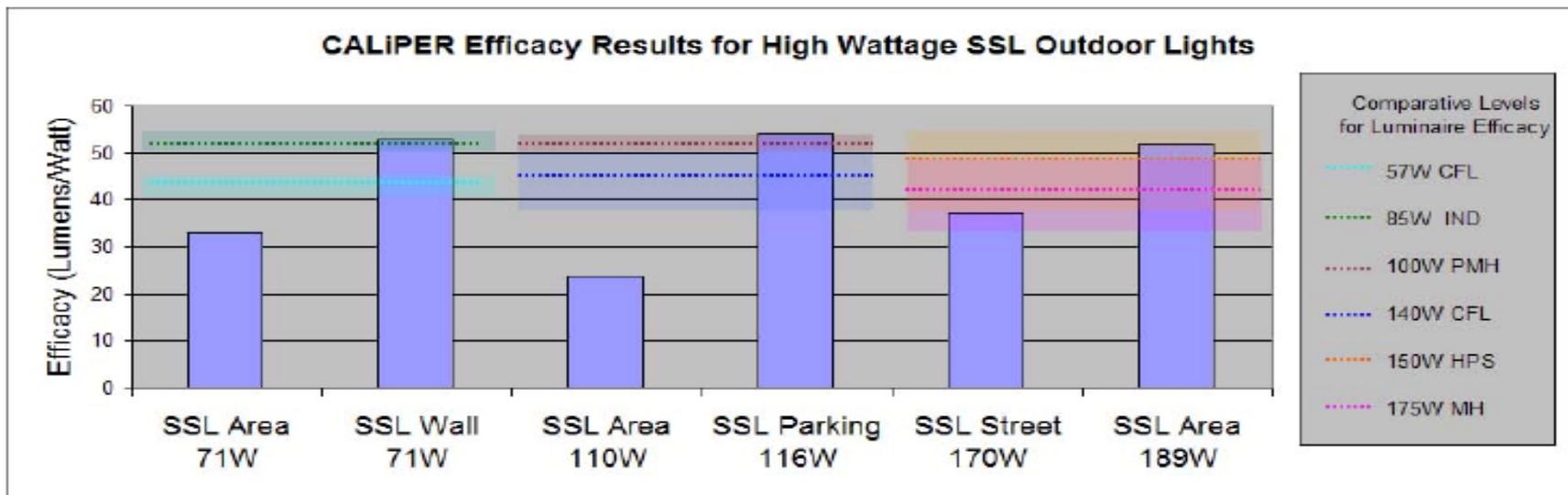
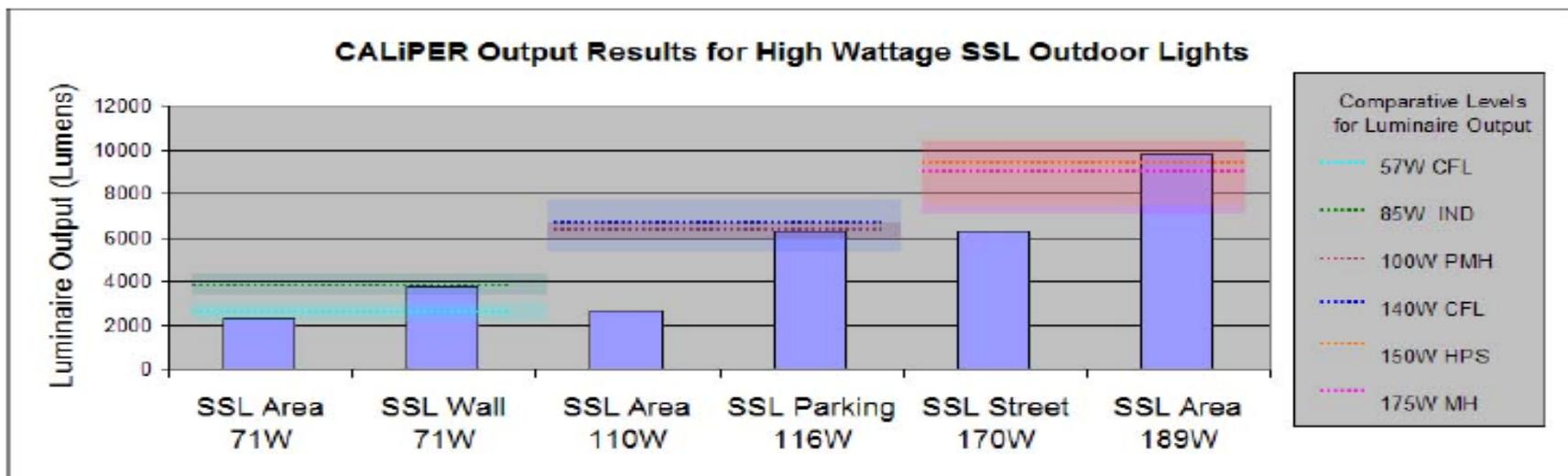
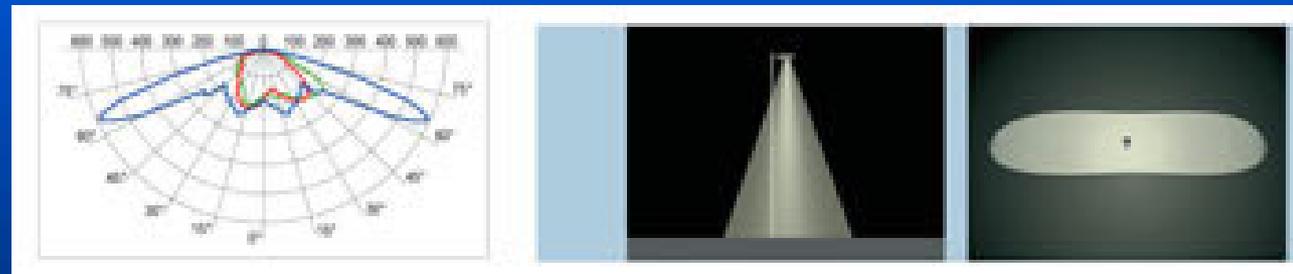
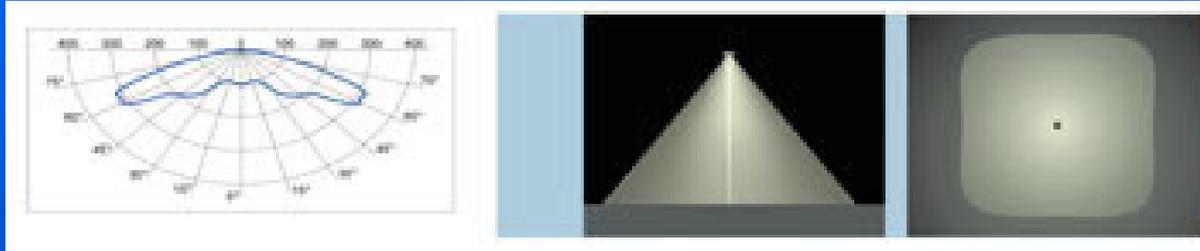


Figure 4. CALiPER Output and Efficacy Values Showing Comparable Levels for Other Light Sources

Comparative levels represent initial luminaire efficacy established using IES files and ballast factors for outdoor area lights, cobraheads, post-top, and pedestrian lights for CFL, induction, metal halide, pulse start metal halide, and high pressure sodium fixtures.

Directional Point Sources

Tunable Optics

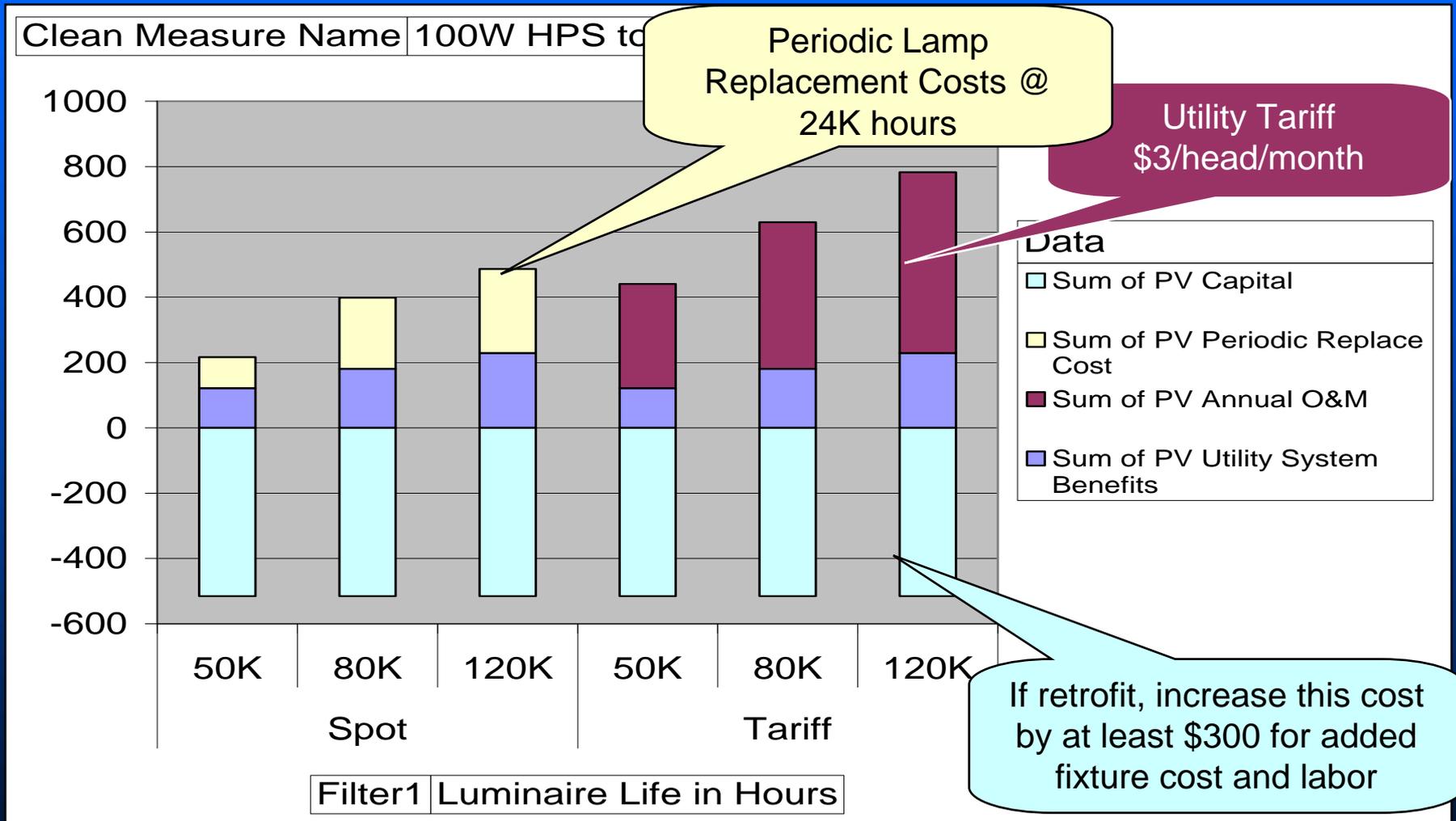


Long Life vs High First Cost

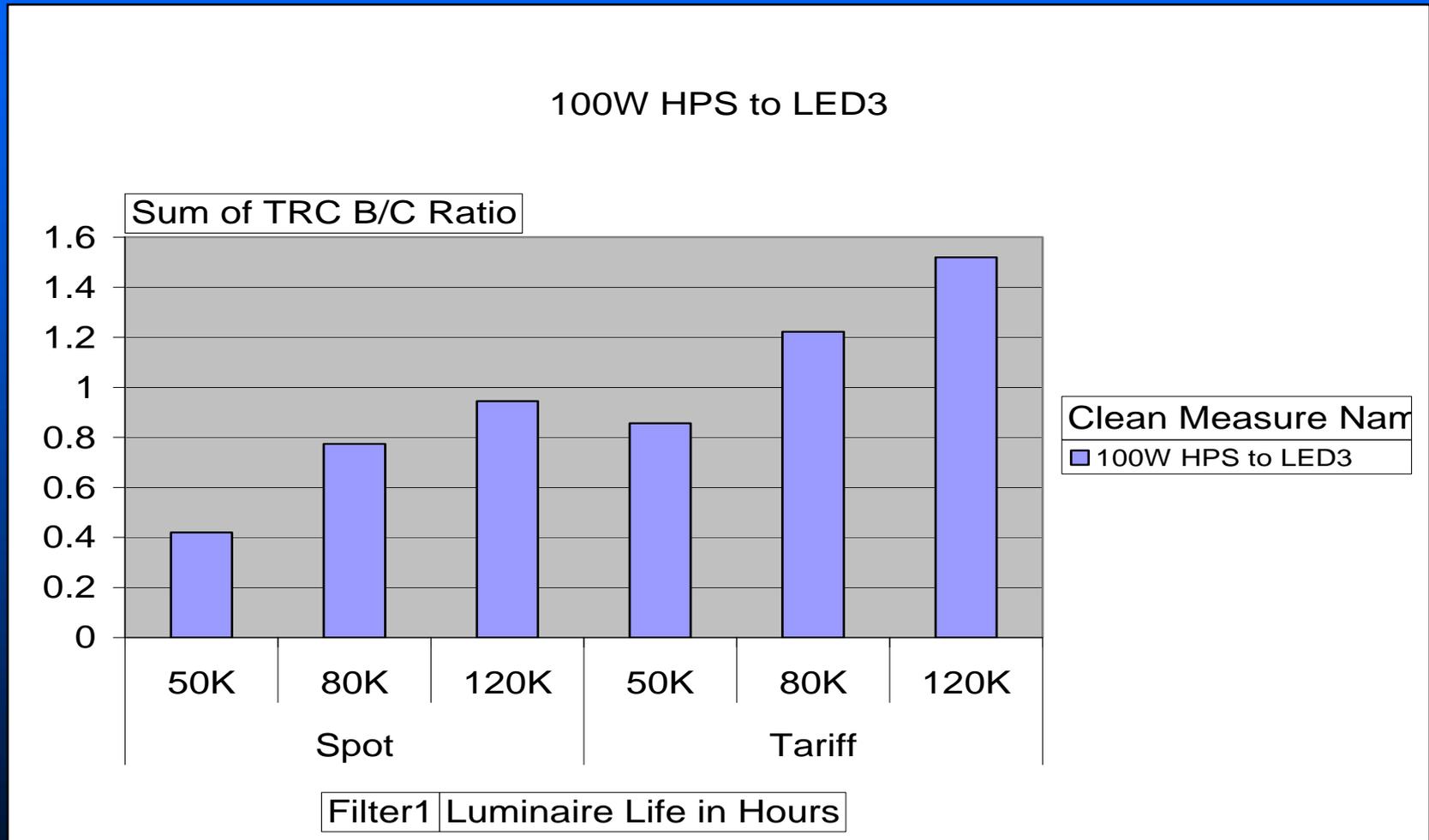
- First Cost vs Periodic Replacement Cost
 - Periodic Replacement Costs Avoided
 - Frequency of Lamp & Ballasts Replacements
 - Reduced Labor Costs



Streetlight – 100W HPS vs LED - New Present Value Benefits (\$ per head)



Streetlight – 100W HPS vs LED - New TRC Benefit to Cost Ratio

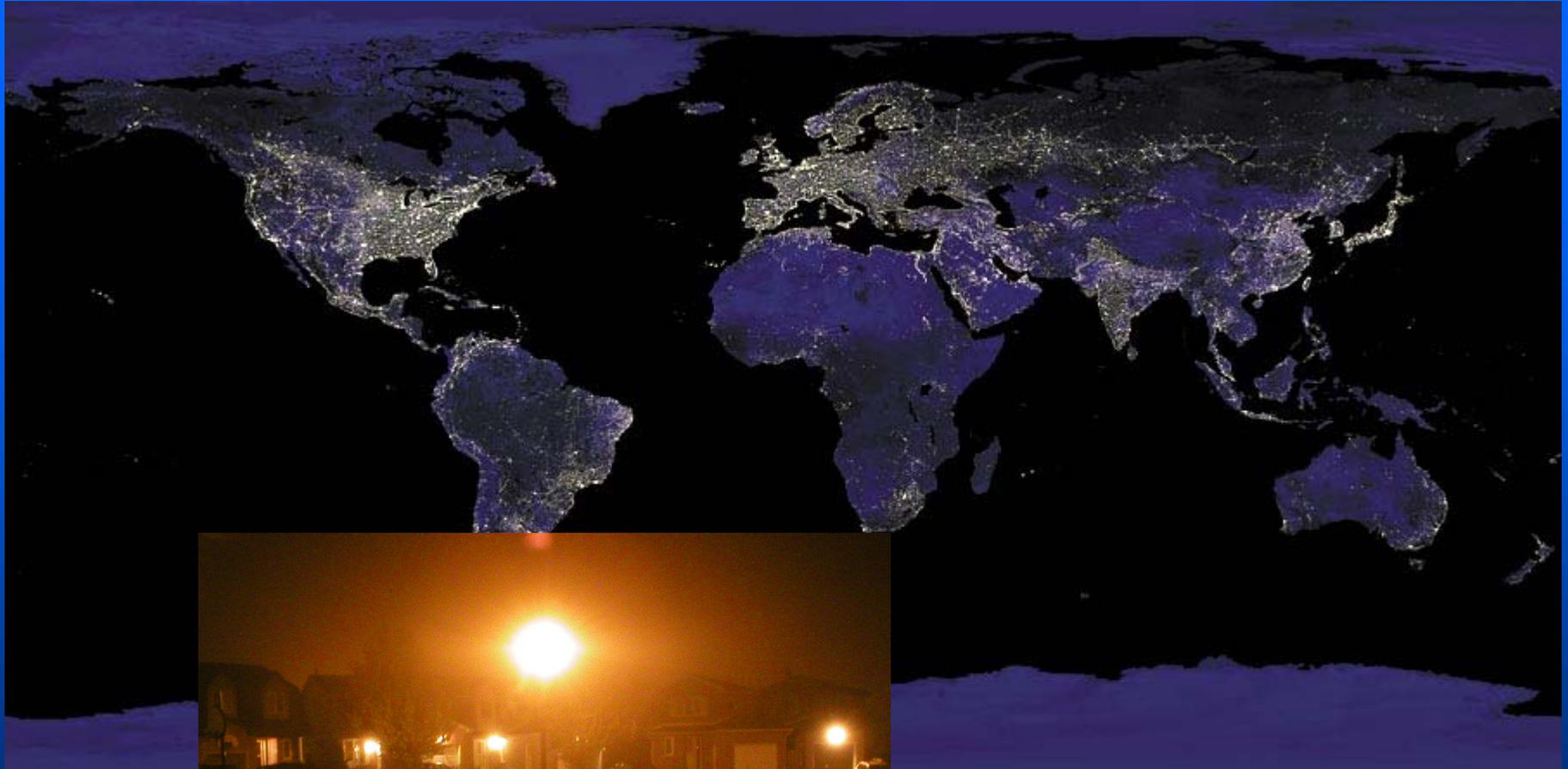


Will LED Roadway Lighting Save our Bacon?

- Roadway Use: 1% of total loads (Navigant 2002)
- For PNW that's 200 MWa total roadway load
- Save 30-40% of that or 60-80 MWa
- How long will it take?



This cobra head HPS fixture was installed in 1981. It's still out there.



Outdoor Lighting

Street, Walkway, Parking, Canopy

■ Similar Economics

- Half or more of the energy savings are from better luminaire & application
 - » As opposed to source efficacy
- Half of \$ value from lower periodic replacement costs (lamp changes & labor)
- High component of nighttime savings
 - » Value of savings is lower

Outdoor Lighting

Street, Walkway, Parking, Canopy

- Promising near-term savings (10% - 50%)
 - Efficacy as good or better than HPS & Metal Halide
 - Lots of room for improvement over existing stock
 - Less wasted light: Improved visibility, better color rendering & contrast ratios, fewer night sky issues, occupancy & dimming options
 - Need designs for long system life
 - » It's the whole package

Long Life vs High First Cost

■ Risks

- Is long life a liability?
 - » Will better technology come along before break even?
 - » Will host site change?
- Does long life really reduce labor cost?
 - » System life (source, fixture, driver, photocell, optics, cleaning regime)
- Life & Efficiency are independent
 - » Will other technology provide long life benefits at lower cost?
- High non-energy benefits mean lower utility program incentives

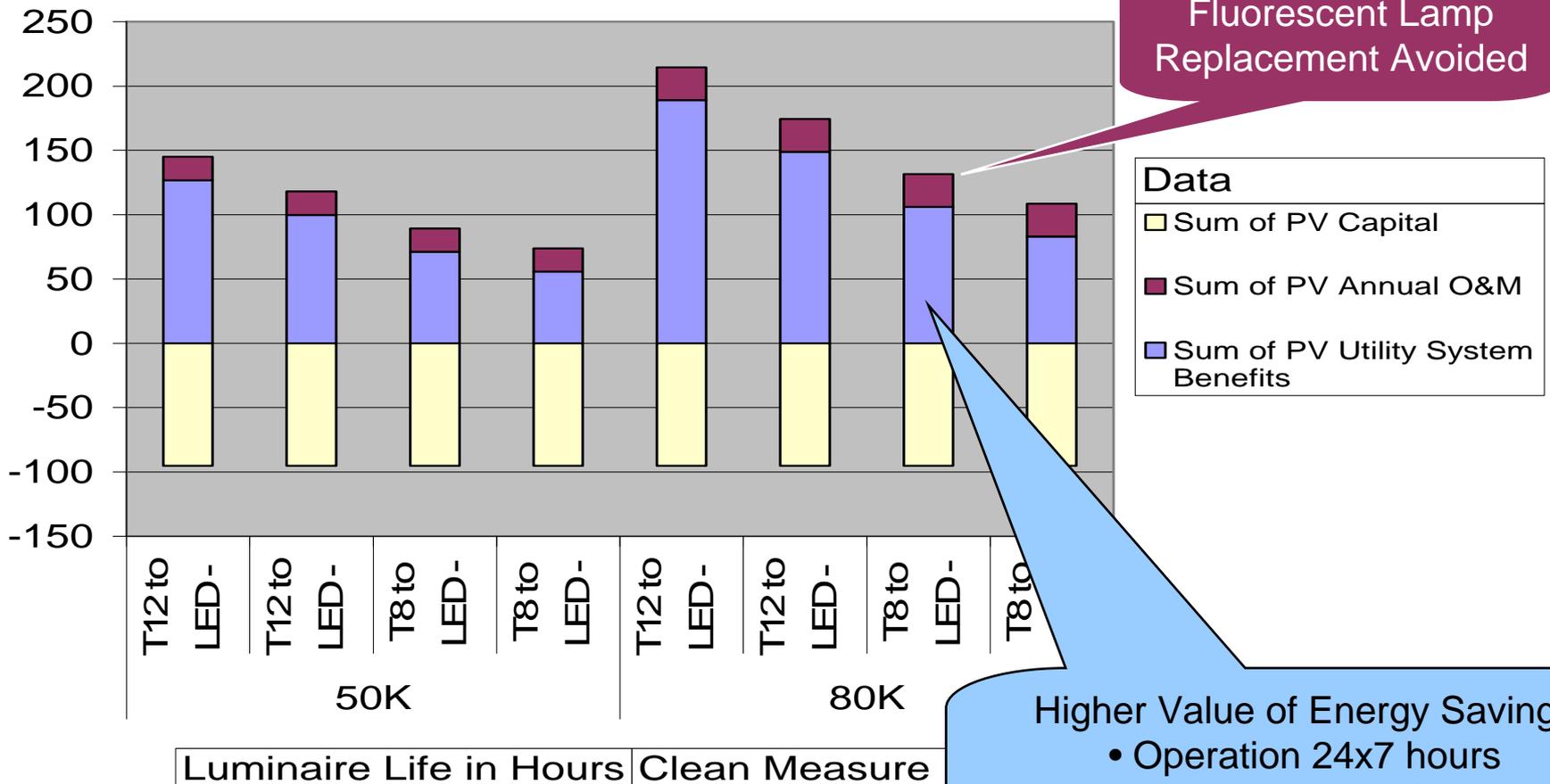
Refrigerated Display Case



- Replaces T-12 & T-8 fluorescent
- Long hours of operation per year (18 to 24 hours/day)
- Cool ambient application & potentially long life
- Saves refrigeration energy too
 - Savings multiplier 1.3 to 1.7
- With occupancy sensors – more savings

Refrigerated Case Lights

Present Value Benefits (\$ per linear foot case)



Fluorescent Lamp Replacement Avoided

Data

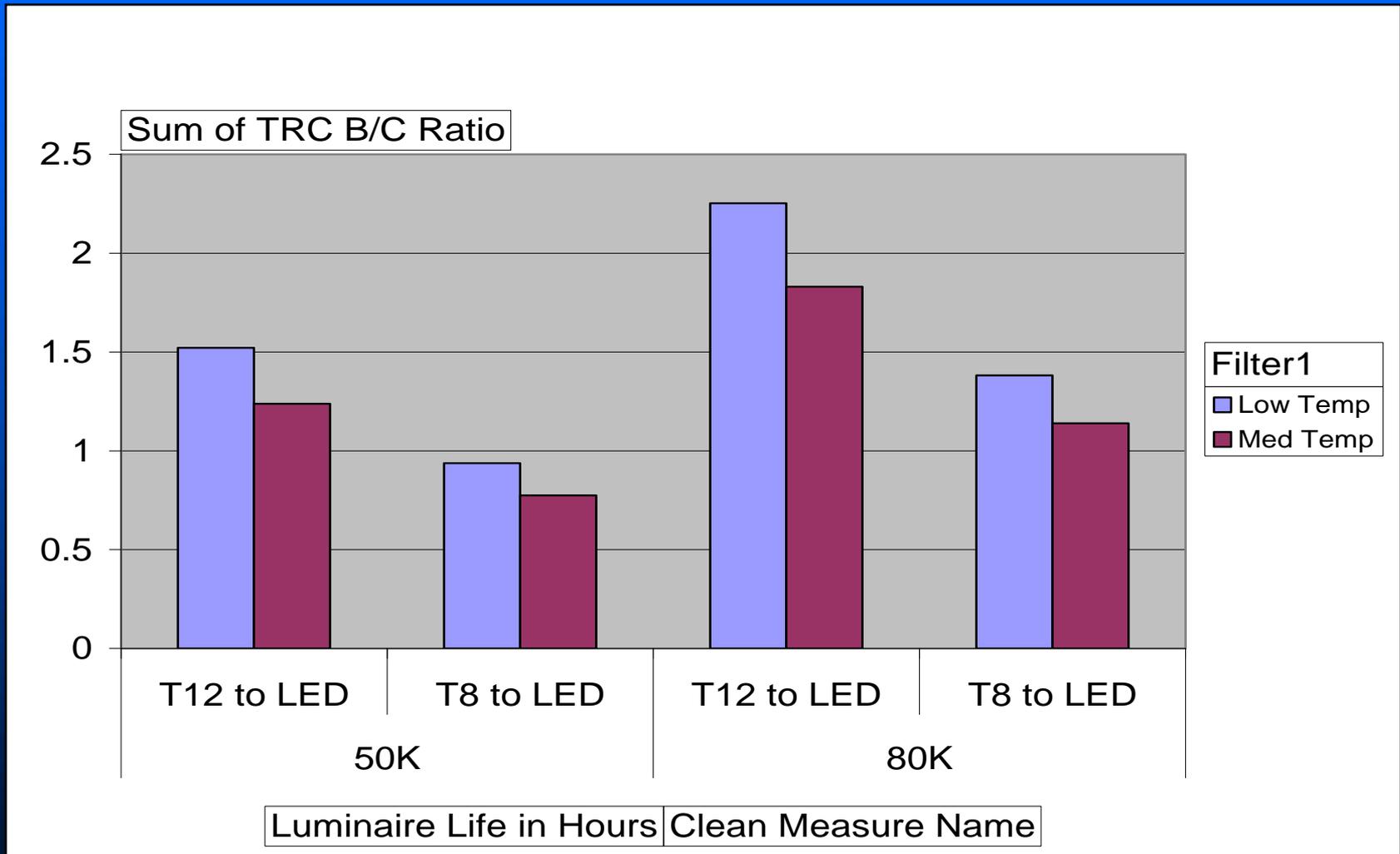
- Sum of PV Capital
- Sum of PV Annual O&M
- Sum of PV Utility System Benefits

Higher Value of Energy Savings

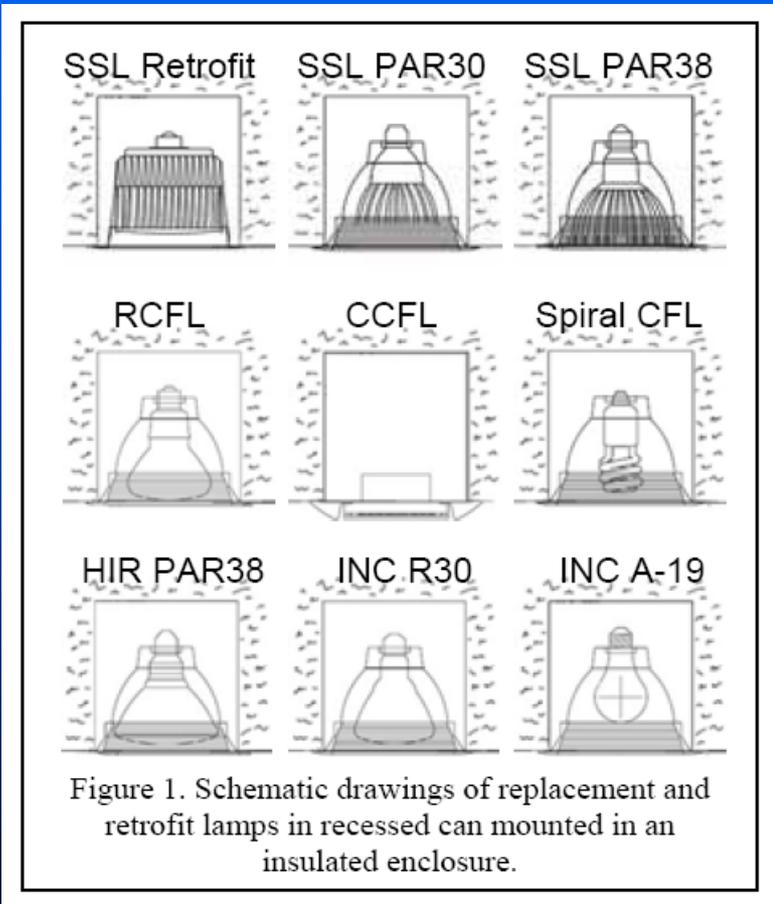
- Operation 24x7 hours
- Higher Avoided Costs
- Refrigeration Kicker

Refrigerated Case Lights

TRC Benefit to Cost Ratio



Interior Downlights- Residential





CATALOG NUMBER:	
TYPE:	NOTES:

LR6 6" Downlight Module

Product Description

The LR6 is a downlight module for new construction and retrofit that installs easily in most standard six inch recessed IC or non-IC housings. The LR6 generates white light with LED's in a new way that enables an unprecedented combination of light output, energy efficiency, beautiful color, and affordability. U.S. Patent # 7,213,940 issued. Numerous patents pending.

Performance Summary

- Nominal delivered light output – 650 lumens
- Nominal input power – 12 Watts
- CRI – 92

Ordering Information

LR6 – 120V, Incandescent Color (2700K), Edison Base (STANDARD)
 LR6-GU24 – 120V, Incandescent Color (2700K), GU24 Base
 LR6C – 120V, Neutral Color (3500K), Edison Base
 LR6C-GU24 – 120V, Neutral Color (3500K), GU24 Base



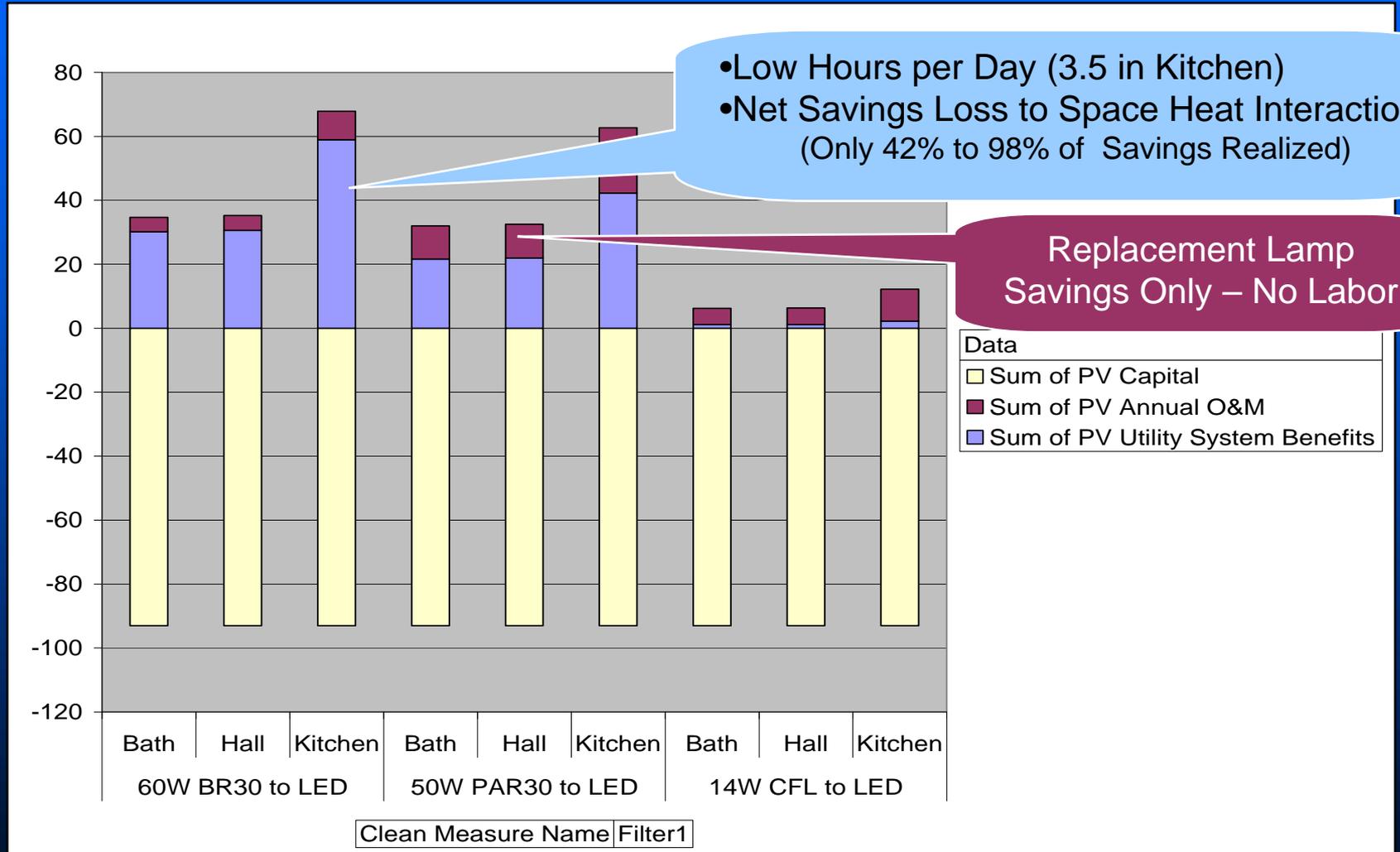






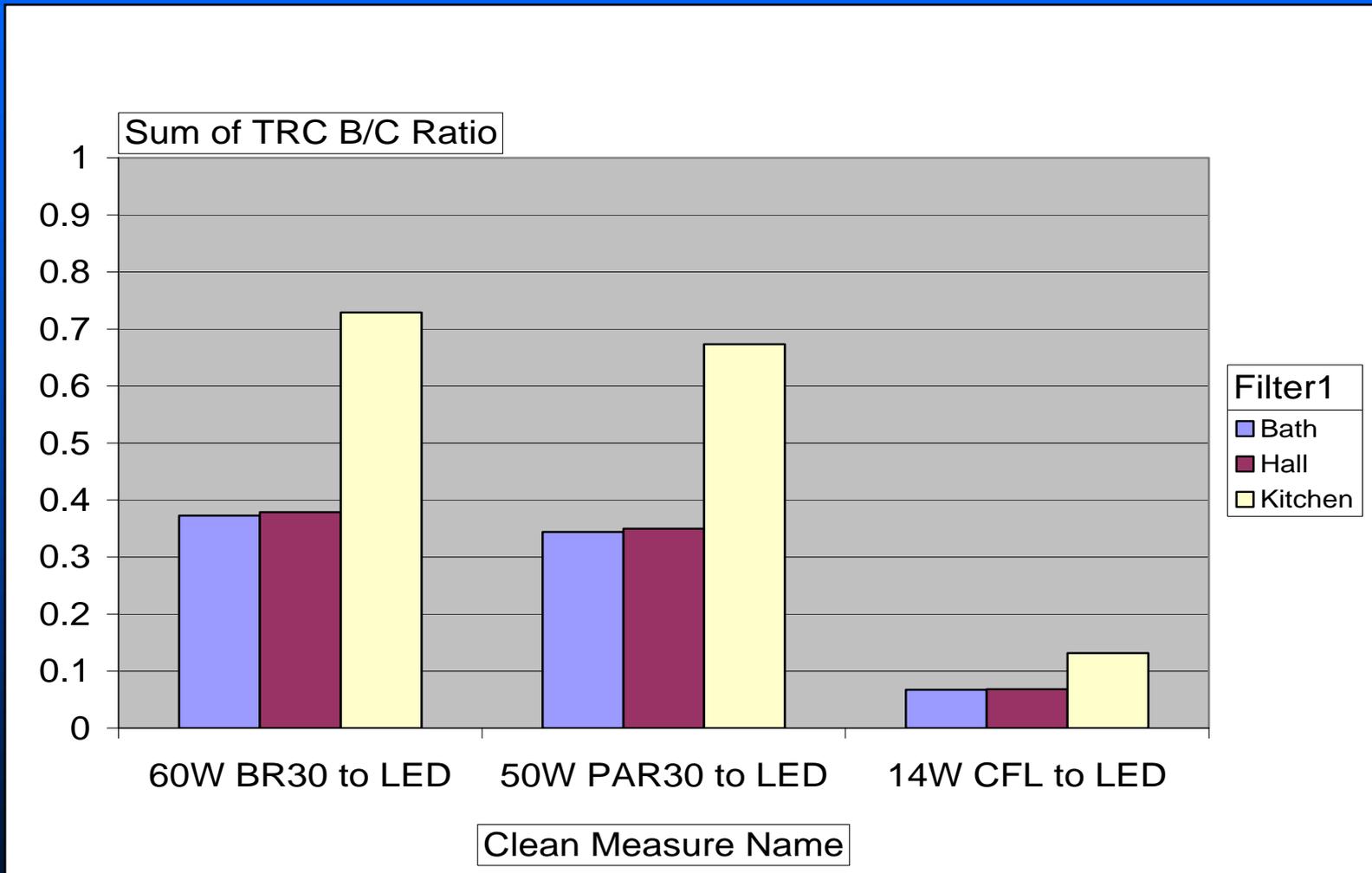
Interior Downlights- Residential

Present Value Benefits (\$ per fixture)



Interior Downlights- Residential

TRC Benefit to Cost Ratio



Interior Downlights - Commercial

- Economics look better than Residential
 - Higher operating hours per year
 - Longer EStar LED life (35K vs 25K Residential)
 - Somewhat higher savings realization on HVAC
 - Labor savings
 - May be cost-effective over PAR & BR >3000 hrs
- But baseline in commercial new construction is CFL
 - SSL not close to cost-effective vs CFL (2 watt delta)
- Commercial has higher ceilings
 - Need higher SSL luminaire output

Summing Up: Economics

- Your mileage may vary
- All costs & benefits
- Careful choice of alternatives
- Do your homework



Emerging SSL Risks

- Cost per Useful Light Declining Fast
 - Some value in waiting before large scale programs
- High Non-Energy Benefits
 - Long Life not unique to SSL
 - Utility program design implications
 - Long Life - Asset or a Liability?
- Still learning to Design & Apply SSL

Emerging SSL Rewards

- High value in demonstration projects now
 - Much we don't know
 - Mistakes are valuable
 - » Lead to Better Products & Applications Sooner
 - Early part of cost reduction curve
- Need regulatory leeway to experiment



*"How far that little
candle throws his
beams and so lights the
way in a naughty world"*

The End

Charlie Grist
Northwest Power & Conservation Council

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