# Demonstration of Energy Efficient Retrofits for Lighting and Daylighting in New York City Office Buildings

2015 Building Technologies Office Peer Review

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

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# Project Summary

**Timeline**:

Start date: October 1, 2013

Planned end date: December 31, 2015

Key Milestones

1. Partner commitment to Living Lab investment, 1/31/14
2. Initial implementation, 6/14, 8/14
3. Final technical report, procurement specifications, and education/ training requirements, 12/30/15

**Budget**:

Total DOE $ to date: $400K

Total future DOE $: $500K

**Target Market/Audience**:

Commercial buildings; retrofit applications; owners, architects, engineers, manufacturers, regulators, utilities

**Key Partners**:

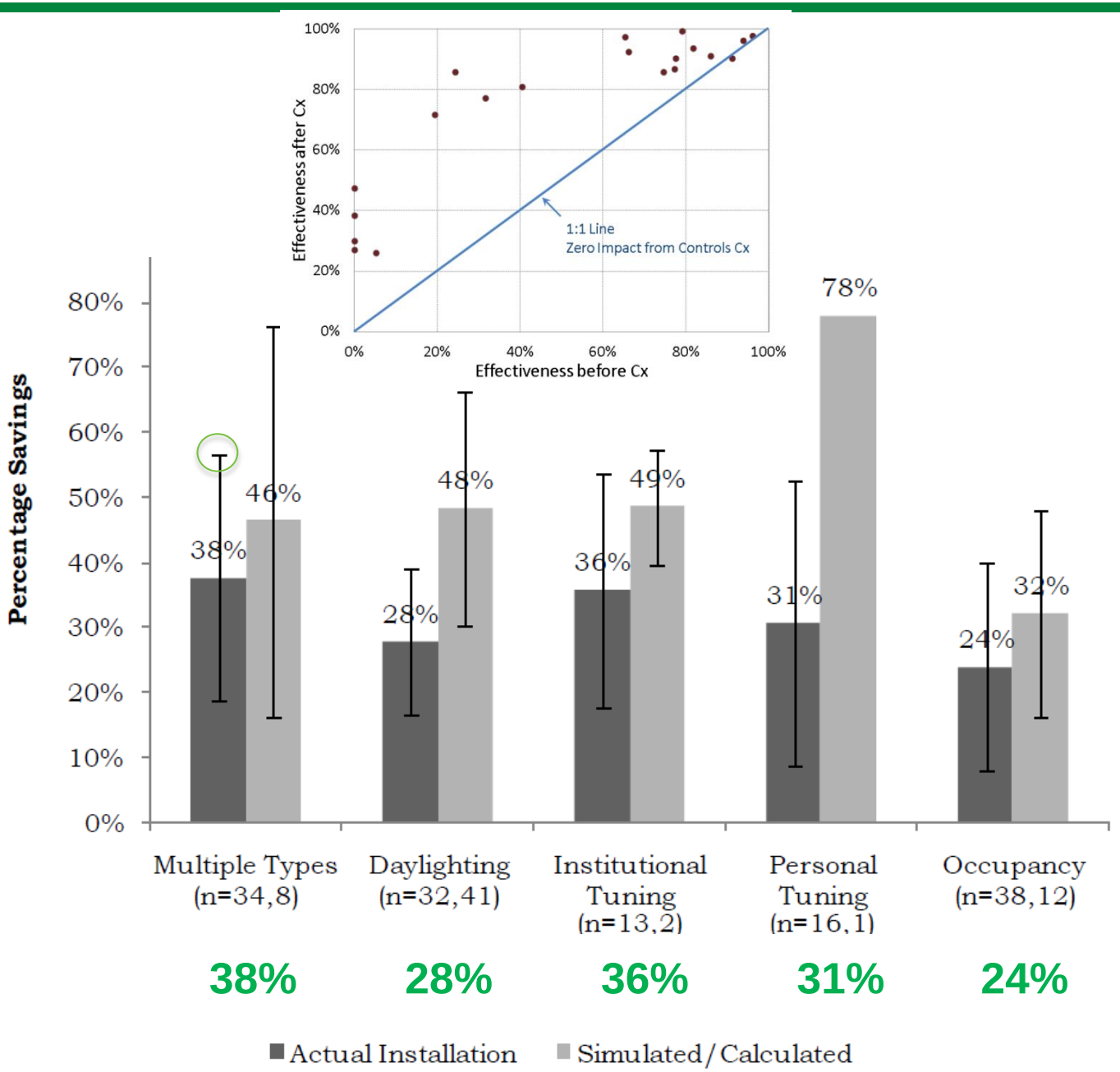
| | |
|---|---|
| Green Lights New York/ Building Energy Exchange | Steven Mesh, Lighting Education & Design |
| Bank of America | Goldman Sachs |
| HDLC Lighting Design | Sustainable Energy Partnerships |
| NYSERDA | Manufacturers |

**Project Goal**:

Demonstrate market feasibility of implementing cost-effective, energy efficient retrofits for lighting, shading, and daylighting systems in existing office buildings.

# Problem Statement: How do buildings really perform?

- 24-38% measured lighting savings for individual & multiple strategies
- Daylighting savings increase significantly if properly commissioned




Sources: (bottom) Williams, A. et al., 2011, A meta-analysis of energy savings from lighting controls in commercial buildings, LBNL-5095E; (top) Hackel and Schuetter, 2013, Commissioning for optimal savings from daylight controls, ECW Report 264-1.

**Proof-of-concept:**
**The New York Times Headquarters**
**Digitally-addressable, dimmable lighting + automated shading for new construction 10 years ago**

http://windows.lbl.gov/comm_perf/newyorktimes.htm

# Post-occupancy evaluation: The New York Times HQ

**DOE CBI post-occupancy evaluation 5 years after occupancy found that the systems worked well (dimming, shading, UFAD); savings compared to a similar code-compliant building**:

- 3.15 kWh/ft$^2$-yr lighting energy use, 56% savings
- 29.2 kBtu/ft$^2$-yr (39.3 kBtu/ft$^2$-yr for 90.1-2001) total EUI, 26% savings
- 21-25% reduction in summer peak demand
- Economic paybacks appear reasonable
- Overall occupant satisfaction was high; some areas need refinement

**How can these technologies be cost-effectively and broadly deployed for retrofit applications?**

# Purpose and Objectives

## Target Market and Audience

- Commercial buildings; retrofit applications; owners, architects, engineers, manufacturers, regulators, utilities

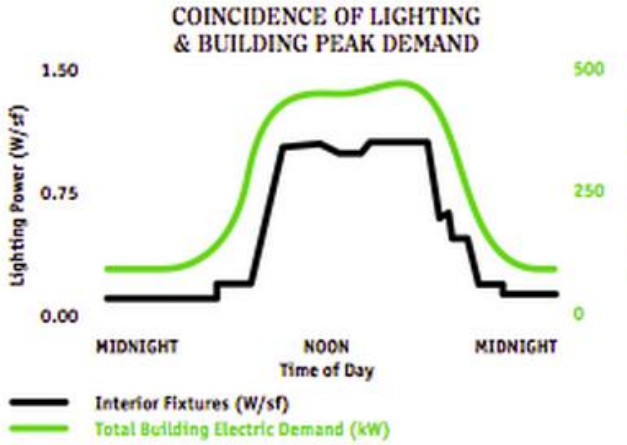
## Impact of Project

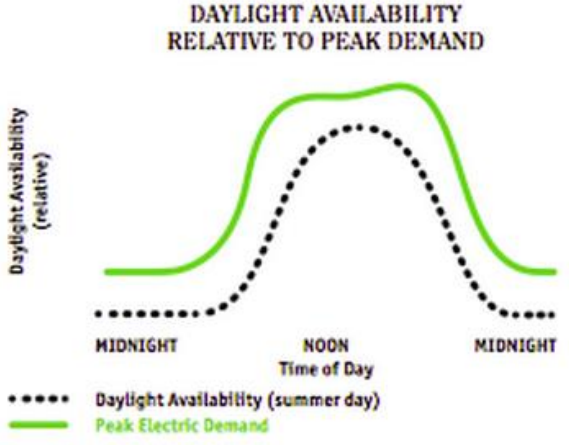
- Identify shading, daylighting, and lighting technology upgrades that can be cost-effectively retrofit into existing buildings and provide significant energy savings, increased comfort, and added amenity to the owner, facility management team, and end users.
- ***Near-term***: Identification of key design, bid, and procurement strategies and cost-effective technological solutions that can be broadly deployed in the market
- ***Intermediate-term***: Increased awareness of the options for controllable façade and lighting systems for retrofit application
- ***Long-term***: Widespread adoption of integrated shading, daylighting, and lighting systems for retrofit applications

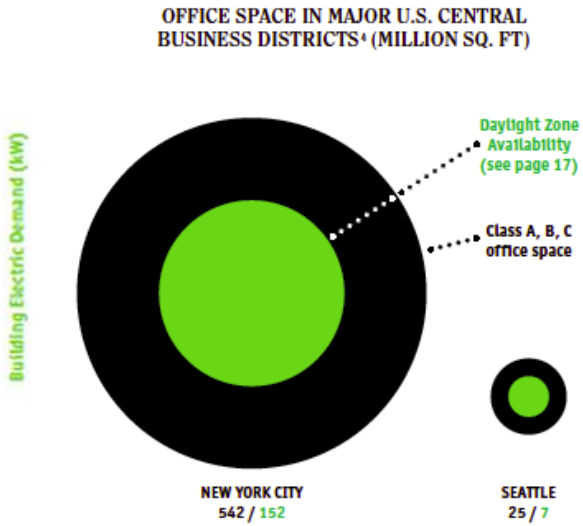
# Approach

## Context

- Green Lights New York issued “Let There be Daylight”* – a blueprint for illuminating NYC’s commercial space to enable 160 MW of peak electric demand reductions and 340 GWh of electricity savings for greater grid reliability and resilience in aftermath of Hurricane Sandy in 2012
- Local Law 84 on benchmarking: public disclosure of building energy use
- Local Law 88 requires upgrade of lighting and installation of sub-meters for each large tenant in multi-tenant commercial buildings




* http://be-exchange.org/resources/project/31

# Approach

1) Create a “Living Laboratory” on a floor of each of two commercial office buildings (and reference floor), procure and install innovative shading, daylighting, and lighting technologies, then monitor to evaluate performance under occupied conditions.
2) Promote strategies and technologies for retrofit applications broadly throughout the US.

**Key Issues**

- Address business case for cost payback
- Level of engagement of facility management staff
- Occupant response, comfort, and satisfaction with automatic controls

**Distinctive Characteristics**

- Combines market instigators with rigorous monitoring and analysis in collaboration with pragmatic building owners

# Baseline metering of floor with existing daylighting controls

Dimming profile of private offices not reflected in floor load shape

Peak lighting energy use also nearly constant between 2-6 PM

# Market Challenge: RFI and Procurement Specification


**REQUEST FOR INFORMATION**

**LIGHTING, DAYLIGHTING & SHADING RETROFIT TECHNOLOGY FOR COMMERCIAL OFFICES**

- **Lighting challenge**
  - Tier 1: 2.0 kWh/ft$^2$-yr
  - Tier 2: 1.5 kWh/ft$^2$-yr
  - Tier 3: 1.0 kWh/ft$^2$-yr
- **Daylighting/ shading system challenge**
  - Daylit 50% of daytime hours in 0-15 ft zone
  - Daylit 20% of daytime hours in 15-40 ft zone
- Minimize visual and thermal discomfort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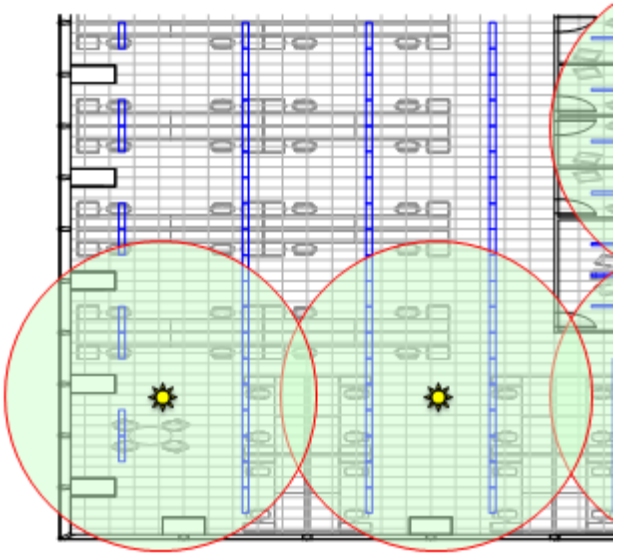
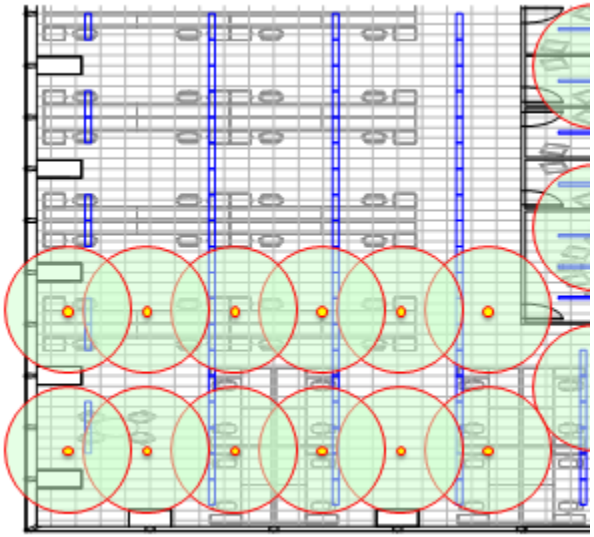
# RFI Outcomes

- **RFI and procurement specifications**
  - Call for pre-proposals released, 12/2/13
  - Site visits and request for Round 2 full proposals, 3/30/14
  - Material pricing received, 4/30/14
  - Labor pricing received, 10/31/14; cost analysis, bid levelling
  - Rescope, rebid, and final internal approvals, 1/31/15
- **Outcomes on cost analysis: Advanced lighting controls**
  - On-site labor is the single most important determining factor for cost in retrofit applications
  - Significant difference in labor if ballasts and ballast controllers are easily accessible/ removable from the fixture
  - Total fixture replacement may be cheaper for some installations, especially if retrofit must be done during nights and weekends

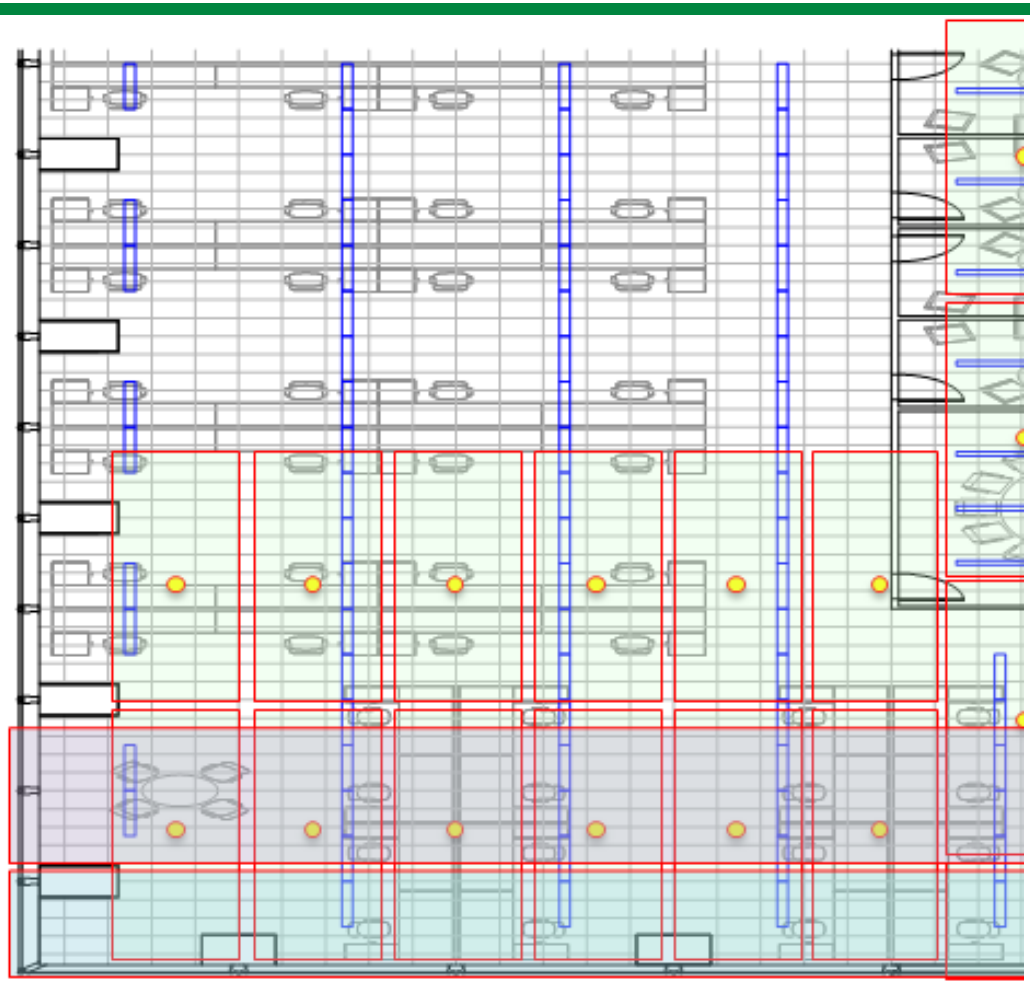
# Advanced lighting controls



Conventional coverage



High-resolution coverage



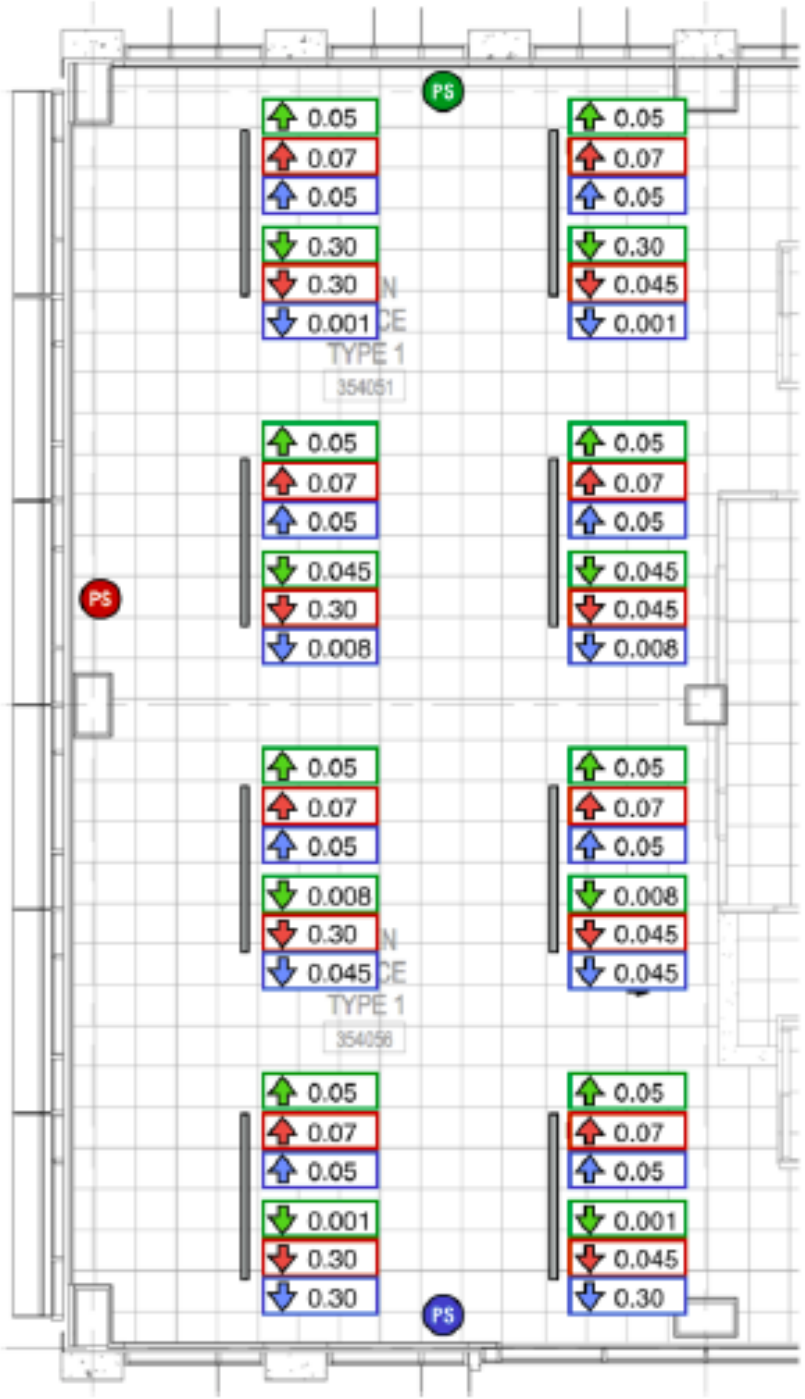
High-resolution occupancy + daylighting control

# Progress and Accomplishments

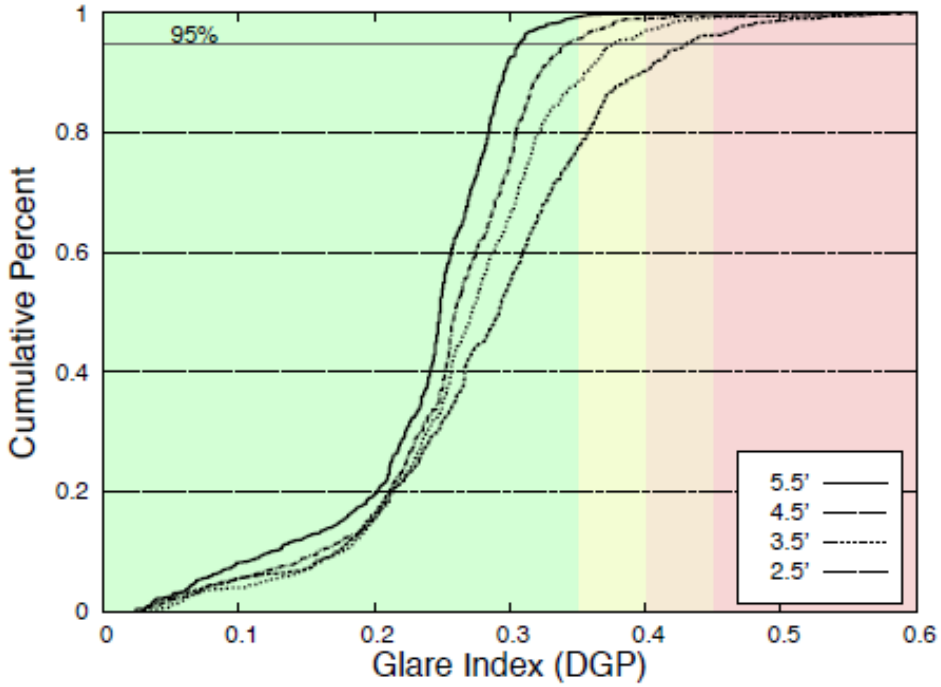
- **Lessons Learned: Advanced lighting controls**
  - The assumption that lighting designers are not needed for retrofit applications is a poor one: codes and emergency lighting require careful design and engineering in collaboration with the controls vendor.
  - Implementation details of the existing lighting system can affect the retrofit solution: existing conditions should be reviewed and considered
  - Installation bids can vary by a factor of 4-5 because there is no standard approach to lighting controls (zoning, sensor-zone control topology) – this adds confusion and increases cost due to perceived complexity by the electrical contractor.
  - Proper staging of installation in occupied spaces can have a significant impact on installation costs (cost tradeoffs to partially vacate the space vs nights/ weekends only for installation)

# Flexibility in photosensor-fixture zoning

## Definition of comfort zone near the window







# Project Integration and Collaboration

**Project Integration**

- Green Lights New York, now Building Energy Exchange (BEEx), Steven Mesh Lighting Education and Design, Sustainable Energy Partnerships, HDLC Lighting provide direct technical support to building owners and contractors.
- BEEx provides regular seminars and workshops in NYC to the architectural lighting community, disseminating findings as the project progresses

**Partners, Subcontractors, and Collaborators**:
*Partners*: Bank of America, Goldman Sachs, GLNY/ BEEx, SEP, HDLC Lighting
*Subcontractors*: Steven Mesh, Lighting Education and Design
*Collaborators*: Manufacturers

**Communications**: LightFair 2014, 2015; GreenBuild 2014; BEEx seminars

# Next Steps and Future Plans

- **RFI/ Procurement Specifications:** Provide version 1 of the specifications for public dissemination in Jul 2015; Final Sep 2015
- **Educational and Training Resources**: Lessons learned during procurement phase; Apr 2015; market factors and national replication opportunities, Sep 2015
- **Monitoring and Verification** (M&V)
  - GS: Make final product selections, order equipment, and install for projected M&V start date of Jun/ Jul 2015
  - BA: Obtain final installation bids for two areas, order equipment, and install for projected M&V start date of Jun 2015
  - Complete M&V by Dec 2015
- **Final updated specs, E&T Resources, and Technical Report** by Dec 2015

# REFERENCE SLIDES

# Project Budget

**Project Budget**: FY14: $500K, FY15: $400K
**Variances**: Schedule delayed due to delays in the procurement process.
**Cost to Date**: FY14: $350K, FY15: $50K ($500K remaining)
**Additional Funding**:
$150K NYSERDA ETAC to Building Energy Exchange;
$680K for lighting and shading materials and installation labor by building owners;
in-kind technical assistance from owners and consultants;
in-kind support from lighting and shading manufacturers.

| Budget History | | | | | |
|---|---|---|---|---|---|
| Oct 1, 2013 – FY2014 (past) | | FY2015 (current) | | FY2016 – Dec 31, 2015 (planned) | |
| DOE | Cost-share | DOE | Cost-share | DOE | Cost-share |
| $500K | in-kind | $350K | $680K | $50K | $150K |

# Project Plan and Schedule