

Demonstration and Evaluation of Post-top Photovoltaic LED Luminaires

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Outdoor Lighting

- ◆ Pros
 - › Safety, security, visibility
 - › Economic development, community pride, crime prevention
- ◆ Cons
 - › Energy use
 - › Maintenance costs
 - › Light pollution



New York State DOT



Project Background

- ◆ Sullivan Renaissance:
Outdoor lighting project goals
 - › Help the communities in the county improve nighttime safety and accessibility, develop local economies, and build community pride
 - › Without increased energy use, environmental pollution, and reduced views of the night sky

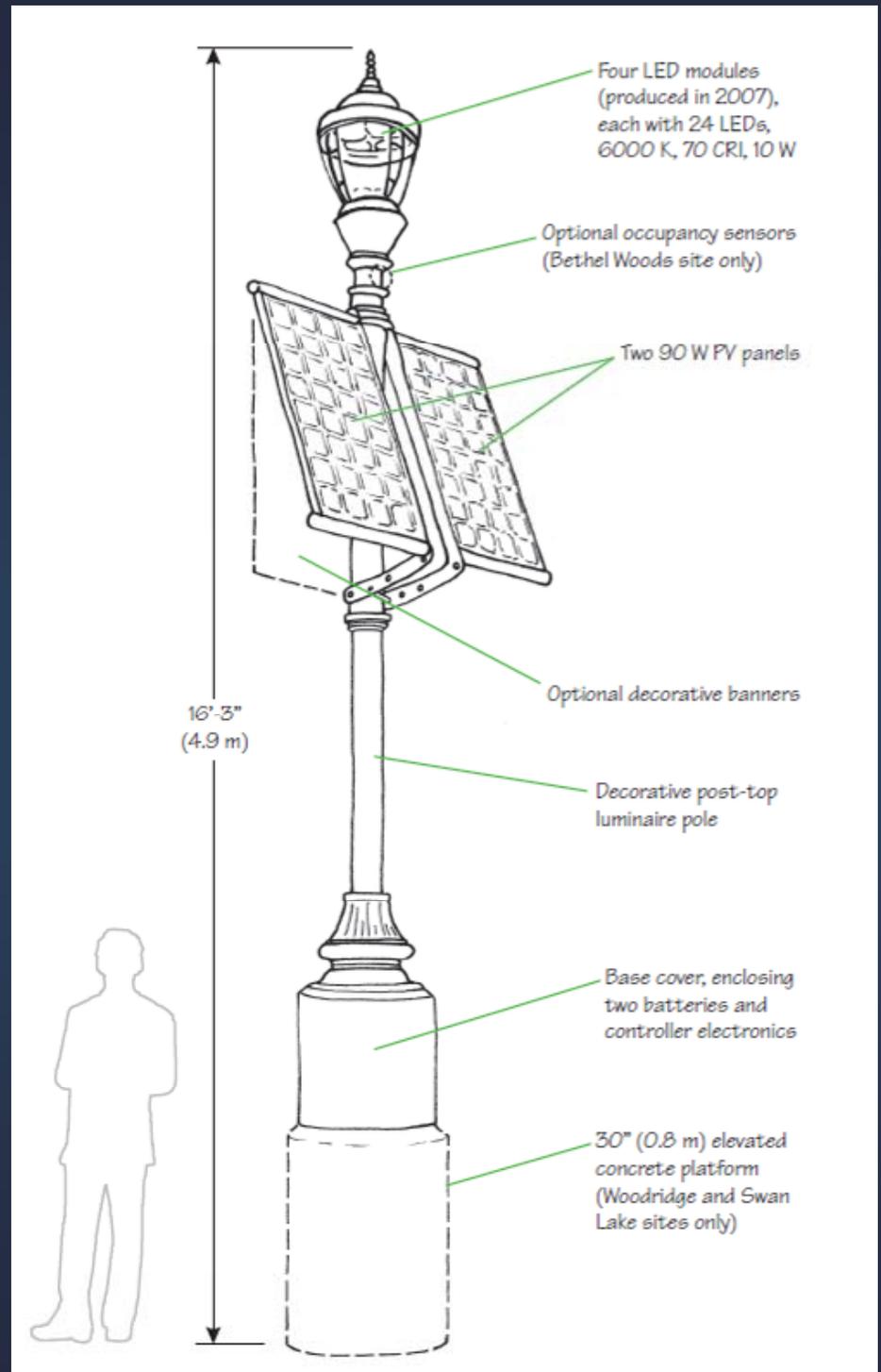


Solution

- ◆ Photovoltaic (PV) Lighting System Design
 - › Based on historic post-top fixture
 - › Philips Hadco and SolarOne Solutions
 - › PV panels integrated like banners
 - › LED lighting – 50,000 hour expected life
 - › Excellent light control and distribution



Solution



Demonstration

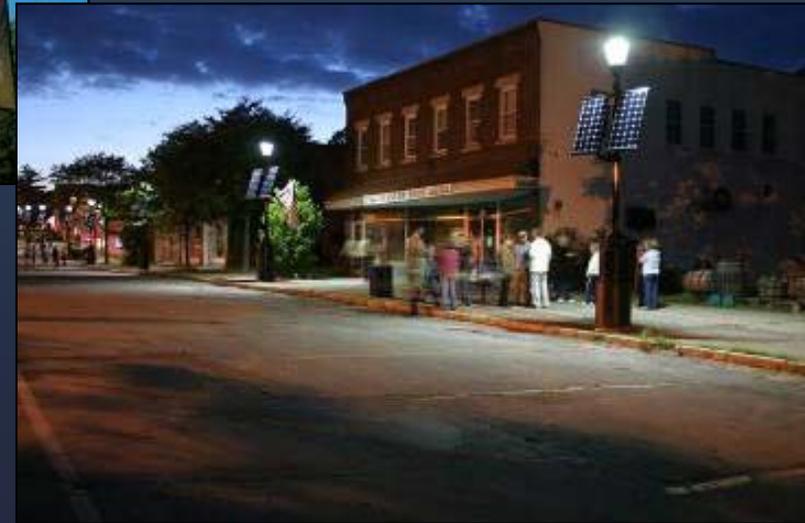
- ◆ Funding received from NYSERDA through a competitive solicitation
- ◆ Three sites selected for demonstration
 - › Diversity of potential applications and environmental conditions
 - › High degree of replicability
 - › Installations completed in late 2007 and early 2008



Photo courtesy: C. Emery

Village of Woodridge, NY

- ◆ Planned to replace the existing electrical wiring along Green Avenue plaza
- ◆ 12 lamp posts installed along a downtown street in the village



Town of Liberty – Swan Lake Park

- ◆ Six lamp posts at Swan Lake Park
- ◆ Positioned along a boardwalk next to a lake



Bethel Woods Center for the Arts

- ◆ Country road, minimum ambient light
- ◆ Six lamp posts
- ◆ Parking area for the 1969 Woodstock Festival monument



Phillips HADCO



Evaluation

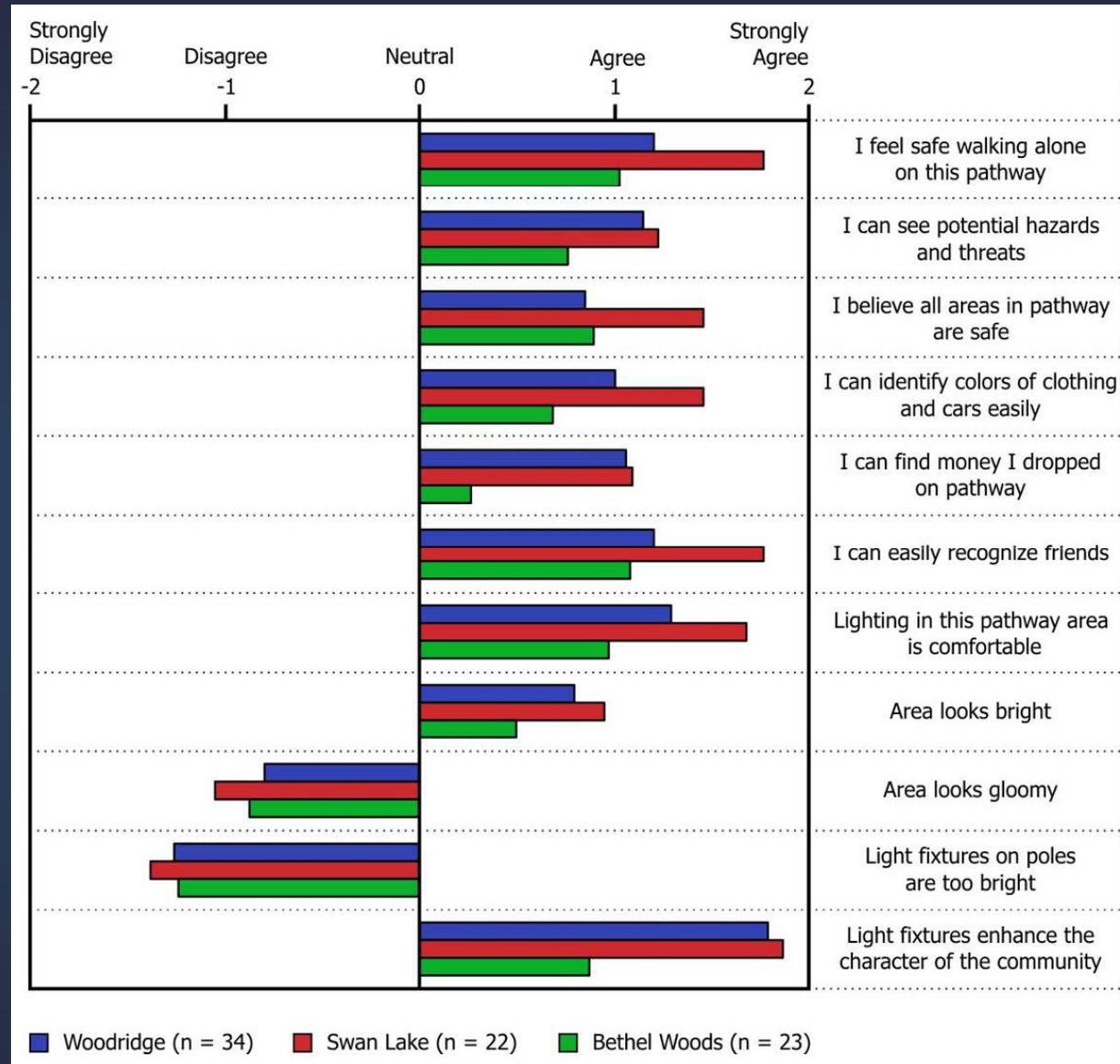
- ◆ Conducted by the LRC, included:
 - › Performance of the systems and components
 - › Energy savings
 - › Lighting conditions provided
 - › Life cycle costs
 - › Hours of operation
 - › Maintenance
 - › Residents' opinions of the systems



Photo courtesy: C. Emery

Survey Results

- ◆ All sites
 - › Showed similar positive trends
 - › Bethel Woods site less positive
 - Less frequent visitors
 - Unfamiliar with site
 - Uneven ground materials



Comments

“The lights are a plus to the village and look beautiful; maybe a little more bright.” –Woodridge Resident

“Wonderfully laid-out park: lighting is adequate and has a soft hue.” –Swan Lake Resident

“Light is very soothing to the eye.” –Bethel Woods visitor

“Could be a little more bright.” –Bethel Woods visitor

“The lack of glare is particularly pleasing compared to most fixtures. The subtleness is much more fitting for such a rural area.” –Bethel Woods visitor

“The solar lights are not only functional but beautiful... I filled out this survey and wrote my comments by the light of the solar lamp! Perfect!” –Bethel Woods visitor

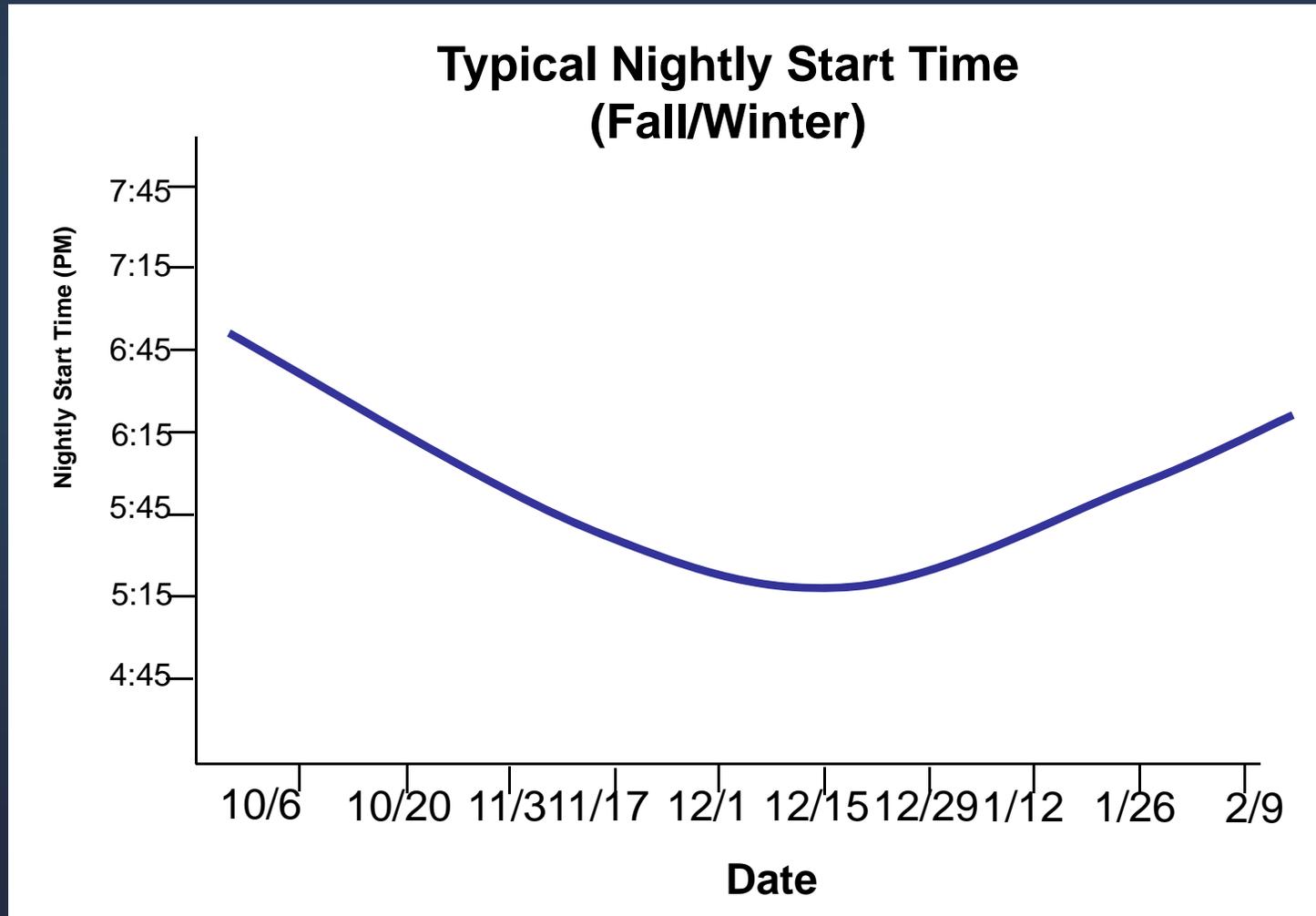
Performance Monitoring

- ◆ Battery-powered light monitoring devices installed at all sites in:
 - › **Summer** June/July 2008
 - › **Fall/Winter** September 2008 to February 2009



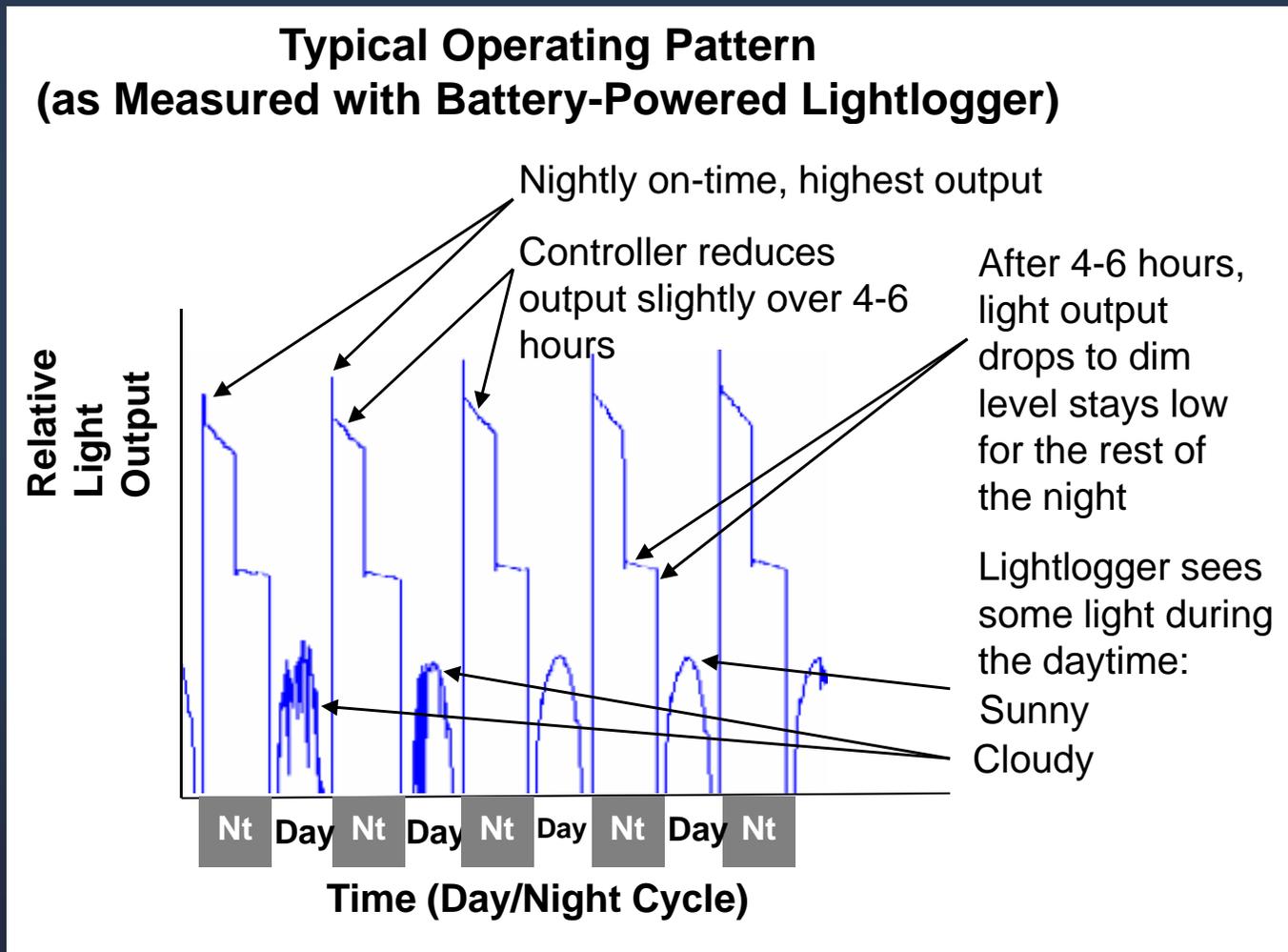
Fall/Winter Monitoring Results

- ◆ All units turned on at about the same time
- ◆ Earlier on shortest days of the year



Fall/Winter Monitoring Results

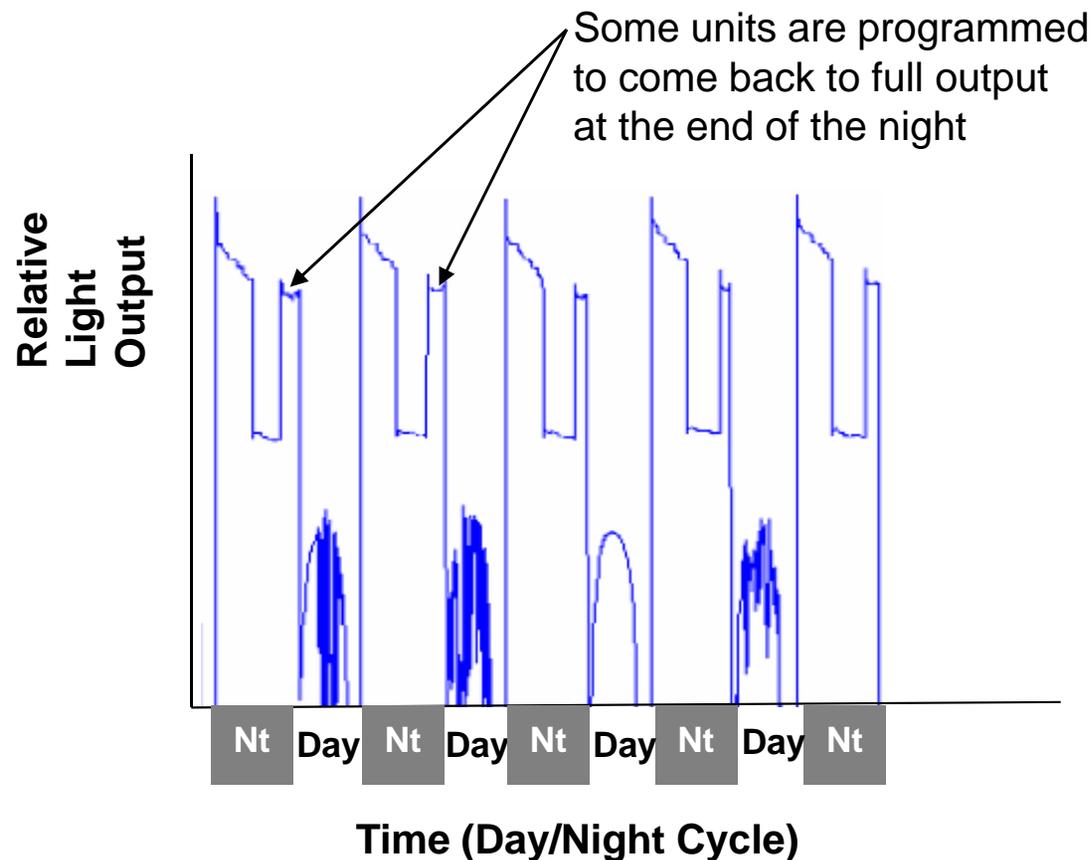
- ◆ All units operated at full light output for 4-6 hours then stepped down to dimmed state



Fall/Winter Monitoring Results

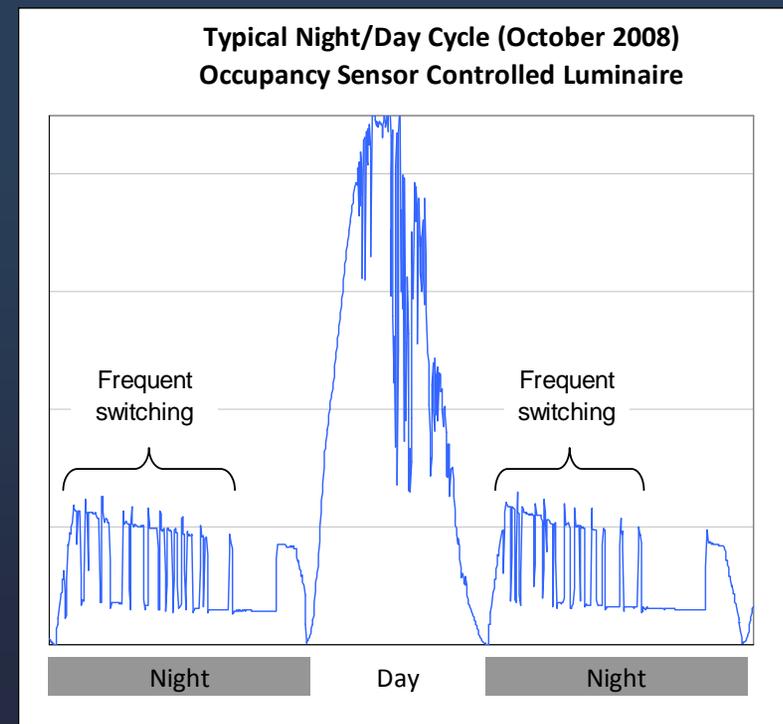
- ◆ Some units programmed to return to full light output before dawn

**Typical Operating Pattern – Morning Program
(as Measured with Battery-Powered Lightlogger)**



Occupancy Sensor Activity

- ◆ Two in Bethel Woods parking lot
- ◆ Dim to low level when no occupancy is sensed
- ◆ Results:
 - › Frequent switching at night
 - › May not have been responding to actual human occupancy
 - › False-offs



Fall/Winter Monitoring Results

- ◆ For about a week in November and December:
 - › Luminaires turned off prematurely, or didn't turn on at all
 - › Possible low voltage disconnect
- ◆ Most of fall/winter, units operated as expected
- ◆ Some units may be staying on after sunrise (terrain?, shading?)



Photometric Performance

- ◆ Woodridge – similar before and after
 - › 1-17 lux horizontal
 - › 1-16 lux vertical
 - › Residents surveyed rated LED system as bright and safe as previous HPS system
- ◆ Swan Lake
 - › 3-20 lux horizontal
 - › 1-15 lux vertical
- ◆ Bethel Woods
 - › 1-10 lux horizontal
 - › 1-9 lux vertical



Installation / Maintenance Comments

- ◆ Easy to install
- ◆ Some issues...
- ◆ A new floodlight impacted operation (one location)
- ◆ Water ingress; housing redesigned
- ◆ Different wiring connectors suggested
- ◆ More robust PV mounting bracket design implemented

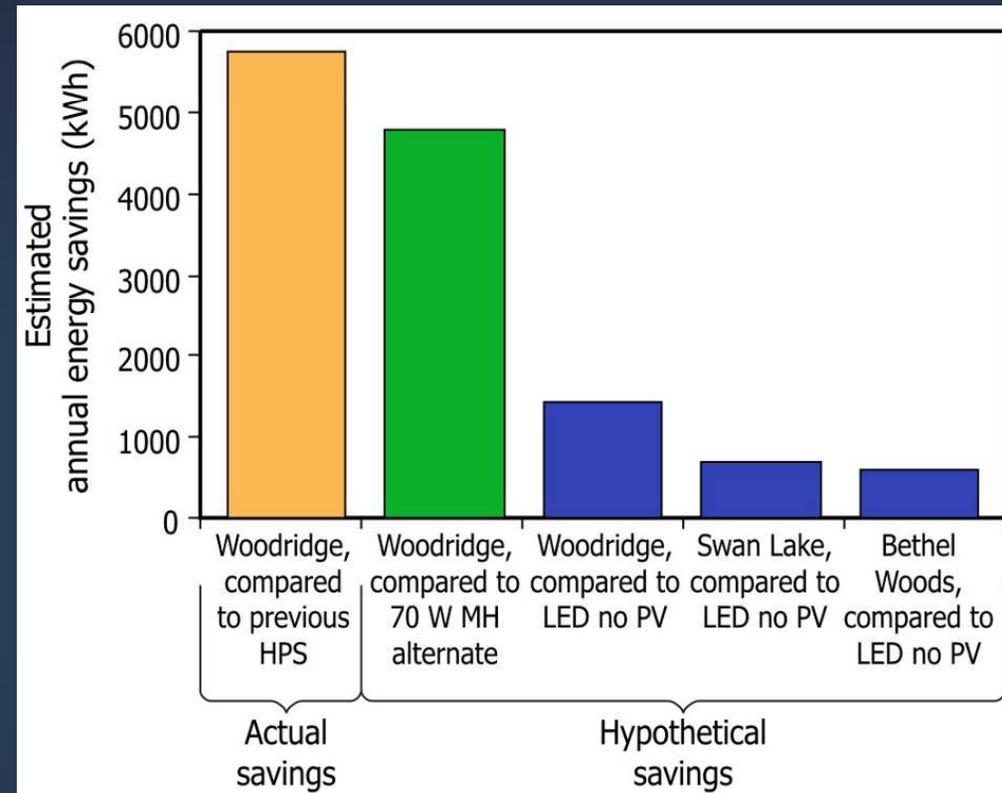


Photo courtesy: C. Emery



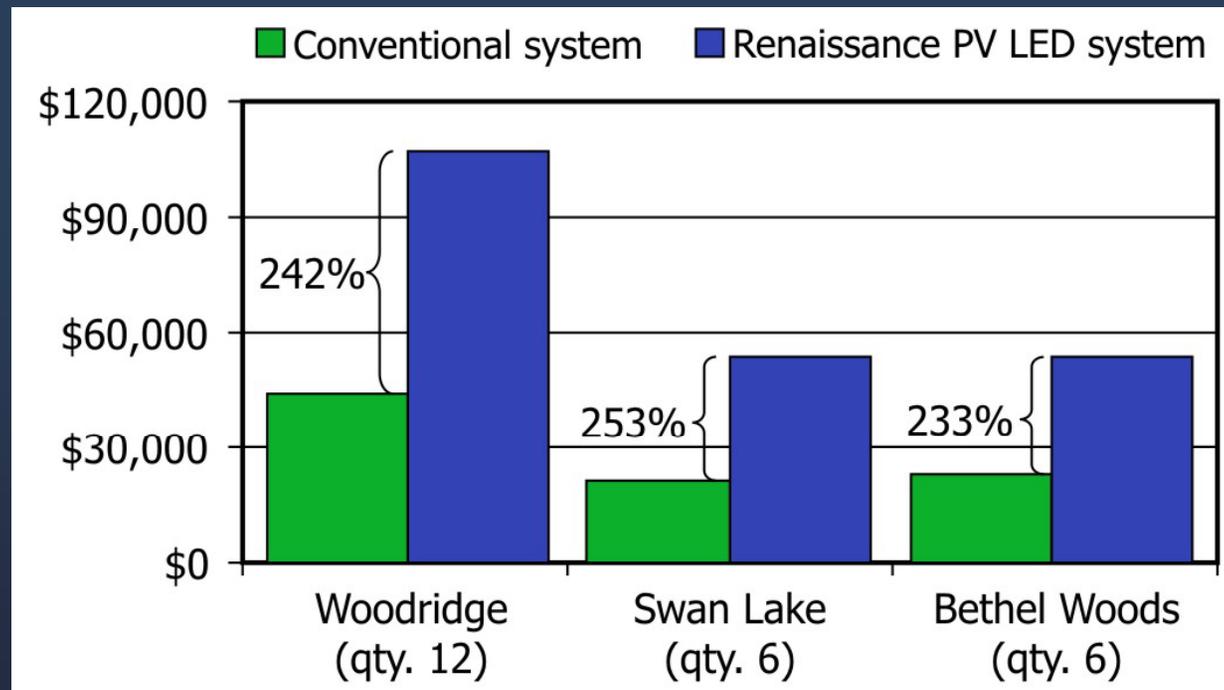
Energy Calculations

- ◆ Save energy by avoiding conventional utility power
- ◆ At Woodridge, actual savings compared to previous system
- ◆ Hypothetical savings, compared to no PV and a conventional luminaire



Life-Cycle Cost Estimates (10-yr)

- ◆ Over twice the cost of conventional system
- ◆ If located further from power, costs would be comparable



Conclusions

- ◆ Community residents liked the PV-powered LED lighting system
 - › Positive feedback on appearance and function
 - › Feel that it provides appropriate illumination
- ◆ Systems generally operated as intended during Summer, Fall, and Winter
- ◆ A PV-powered LED outdoor lighting system may present a viable alternative to grid-connected systems in situations where grid-power is either unavailable, or costly to bring to a site



Acknowledgments

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- ◆ The Gerry Foundation
- ◆ Sullivan Renaissance
- ◆ SolarOne Solutions
- ◆ Philips Hadco Lighting
- ◆ Village of Woodridge
- ◆ Town of Liberty
- ◆ Bethel Woods Center for the Arts



Publications

- ◆ “Demonstration and evaluation of sustainable, photovoltaic powered LED street lighting” Solar 2009 Conference, Buffalo/Niagara, N.Y., May 2009
- ◆ Field Test DELTA: “Post-top Photovoltaic Pathway Luminaire”, October 2009
 - › In print
 - › On-line
- ◆ “Streetlights for Collector Roads”, 2010
 - › On-line



<http://www.lrc.rpi.edu/programs/NLPIP/publications.asp>

<http://www.lrc.rpi.edu/programs/DELTA>