**100,000 Hours of Life & Other LED Fairy Tales**

***Speaker***

John W. Curran, IESNA, ASA, OSA, SPIE - *President*

1. Topics of discussion
    a. Measurements
    b. Standards
    c. Driver
    d. Thermal
    e. Color
    f. Lifetime
    g. Economics

2. History
    a. 1962  0.001 lumen output per one LED
    b. 2000  100 + lumen output per one LED

3. Type of Construction
    a. 5 mm LED old technology – 3lumenslm)
    b. High Flux LED – New technology – dissipates heat better – 75 lm – 1001 lm

4. Photo-optic eye response – 550 peak

5. During night rods respond, so you see black and white – color not important

6. During Day Cones are dominant so color important

7. 3 volt typical to run LED

8. Forward volt required to start current flow

9. LED responds to higher current.  More current = more light out put but not linear.

**Daylight as an Art Form**
***Speaker***s
Lisa Heschong, Architect, IESNA - *Principal*
Davidson Norris, IESNA - *President*

1. Dichroic glass is a useful material for splitting up light as it enters a space.

2. Using a wall with blades creates an animation of what is going on behind the surface.

3. Adding Dichroic glass to a boring building façade adds light to an otherwise bland street.

4. Utilize dichroic reflective glass to reflect cool patterns on the wall with a "target" in mind.

5. Use cool art glass pieces that interact with daylight

6. 7 World Trade Center in New York City uses reflected light to make the building appear camouflaged to the sky.

7. A Heliostat can be used to track the sun and reflect direct sunlight into a room or tube using mirrors. Try to creatively use a heliostat to bring natural lighting into a building.

8. Daylight can also be used as a calendar (Interesting project idea)

9. How to create Indiana Jones atmosphere in kids areas at recreation centers:
    a. Could use laser pointers
    b. Could also just have a cool "clock/calendar"

10. Daylight controls are critical in successful daylight design.

11. Daylight makes a space memorable.

12. "Full Spectrum" daylight is better than all other light sources.

13. Sunlight can be used to create reflective color.

14. Use sun angles to create an oculus to act as a calendar. This is similar to Roman temples and Renaissance churches.

15. A cloth or panel below a skylight is a good low budget way to add quality daylighting to a space.

16. Day and night lighting should have two separate “feelings”. It’s okay to have separate design concepts for each.

17. Don’t try to re-create same lighting solutions with electrical lighting as daylight.

18. Movement and variation of lighting is desirable.

19. Color changes by the time of day.

20. Play with shadows and potentially prisms for variety.

21. Play with colors and how they reflect on to other surfaces.

22. First rule of daylighting – know your sun angles
    - Sundials inside buildings
    - Romans mastered this – way back when

23. In California, over the course of a year, the average sun angle is 30°

24. Use daylight in smaller doses as a splash of attention.

25. Solo tubes are nice, but aesthetically there can be better solutions with varying monitors/skylights and ceiling treatments.

26. Black or dark surface behind glass can create reflections
    - Keep walls behind glass white/bright to reduce reflections

27. If there is too much sun, pretend you are outdoors
    - Add solar shade structures

28. Create a glazing wall is like lining it with light fixtures
    - Very useful overhead

29. For exterior lighting you can create playfulness with holes cut in patio roof structure to bring in freckles of sunlight that move.

30. Special moments that happen with lighting at specific times of the year
    - Phoenix Central Library at Summer Solstice

31. Be careful with electric vs. Daylight designs competing with each other

**Dynamic Daylighting Metrics**

***Speaker***

Andrew McNeil, PE, LEED® AP- *Lighting Consultant*

1. (3) Types of Analysis
    a. Static
    b. Dynamic
    c. Climate Based

2. Daylight factor
    a. Does not consider sunlight
    b. Building orientation doesn't matter

3. Sun Penetration Software
    a. Doesn't consider intensity

4. Typical Days
    a. Sample of specific days and time

5. Climate Based
    a. Daylight coefficients
    b. Divide sky into 145 patches

6. Sunlight coefficients

7. LEED uses Daylight Factor

8. Avoid over analyzing and showing numbers to clients

9. Daylight coefficients are used to calculate light levels during most times of the year using a multiplication factor instead of modeling each day of the year.

10. Useful Daylight Illuminance (UDI) is used to determine the actual useful daylight in the space. Daylight less than 10fc is not deemed useful. Daylight between 10fc and 200fc is useful. Daylight greater than 200fc us considered an annoyance and is not deemed useful.

11. Useful software to analyze daylight:
    a. Free Software
        i. Dayism
        ii. Spot
        iii. Radiance
    b. Commerical Software
        i. Ecotect + Dayism
        ii. AG132

**Evidence-based Healthcare Lighting Design**

***Speakers***

Paul Mustone, LC, IESNA (Moderator) - *President & CEO*
John Gill, *PE, LC, LEED AP*
Leslie North, PE, LC, LEED® AP - *Principal*
Janice Crosby - *Director, Business Development*

1. The healthcare industry accounts for 17% of the US economy and has created over 1.7 million new jobs since 2001.

2. RP-29 is the IES standard for healthcare lighting.

3. CIMIT and The Pebble Project are organizations dedicated to implementing research and technology into healthcare design.

4. Hospital facilities are including amenities including cafés and libraries to attract patients and maintain staff.

5. Bi-polar patient hospital stays are on average 3.7 days shorter in east-facing rooms.

6. Hospital design is becoming more residential. Keep in mind that light fixtures must still be hospital grade, wipe down, and anti-microbial.

7. In hospital room lighting – if falls can be reduced by 3 per year, their six figure insurance premium pays for itself.

8. Research has shown that giving a patient choice with their environment (such as lighting) allows them to feel more in control when going through a difficult situation.

9. Hospital workers such as pharmacists and nurses have fewer errors at higher illuminance levels.

10. Hospital patients with access to daylight have better sleep quality, reduced agitation and better pain management.

**Focusing LIGHT on SLEEP - The New Frontier in Human Health, Performance, Learning & Productivity**

***Speaker***

Deborah Burnett, ASID, CMG, AASM - *President*

***One thing to point out with this speaker is that she was 60 years old and looked like she was 35*

1. Our bodies are rhythm driven. The circadian rhythm is the primary followed by hormones and neurotransmitters.

2. Cyclic exposure to light helps babies reach their ideal weight earlier in life and increase cranial size.

3. The body is designed to act in protection mode for only 20 minutes. This means that high stress environments actually cause wear and tear on the body.

4. Men who sleep at least 8 hours a night have 24% more HGH (Human Growth Hormone). This is important for the aging process and the overall performance.

5. Sleep becomes less efficient once we have stopped growing and are not longer able to reproduce.

6. As we age it is harder for the body to reach stage 4 REM sleep.

7. Visible light wavelengths affect our sleep. Blue light has a wavelength of 455-492 which means it has a higher frequency. So, blue light is continuously bombarding the eye, causing you to stay awake. Red light has a wavelength of 622-780 which has the opposite effect and helps you sleep.

8. Temperature is also important for getting good sleep. During the day, the room temperature should be 68-72 degrees. But, during the night your room temperature should be cooler at 63-68 degrees.

9. Color of light is just as important as the actual change of light.

10. When you are exposed to bright blue light, your serotonin increases, which helps keep you awake. When you are exposed to darkness, your melatonin increases, which helps you sleep.

11. The color of wavelengths of visible light will soon determine the coloring for housing, office and travel interior spaces in the near future. It has been found that neutral colors in the browns and reds and reflectivities of 20% or lower will help induce healthy sleep and will be used in spaces such as bedroom. Colors in blue and green with higher reflectivities will be used in spaces where people will want

to be more productive such as living spaces, kitchens and offices.

12. Problems with obesity: It has been shown that belly fat around the midsection is more orange in color than other types of normal deposited body fat. There is a direct correlation between sleep and weight, particularly in the unhealthy belly fat. Rooms should be kept as dark as possible starting at between 8:30 and 10:30 pm to induce proper sleep. This includes interior exposure to interior lighting, alarm clocks (other than red), computers, and television which can continue to stimulate alertness reducing healthy levels of sleep.

13. Five main things that will help with sleep:
    a. Have complete darkness at bedtime
    b. Use a red wavelength light for bathroom visits
    c. Have phased daylight early in the morning
    d. Have your thermostat set between 63 and 68 degrees at nighttime
    e. Have low contrast and reflectivity below 20% for walls, ceiling, trim

**Following the Sun II: Energy Sustainability Knowledge from Ancient Cultures**
***Speaker***
Gustavo Avilés, IESNA, PLDA, ACE, ELDA+, DIM - *Lighteam S.A. de C.V.*

1. The sun represents 98% of the solar system's mass.

2. Planets distance ratios are in proportion based on phi. Phi = 1.618.

3. Pyramids are a way of combining horizontality with verticality. This can be seen in the representation of the four sides of the pyramid portraying the four cardinal directions and the point representing the day, opposite night. Similarly the four sides can be thought of season/time, measure, ritual and survival/space with the point representing the equinox, opposite the solstice.

4. Mayan architectural geometry is based on both the morning star and night star.

5. Solar City's layout is based on proportions of planets distances and focused around the distance of Saturn.

**Improving Presentation Skills**
***Speaker***
William Attardi, IESNA, AEE - *President*

1. Entertainment is necessary in a presentation

2. You owe the audience a good performance

3. Pre-preparation
    a. Know your audience (most important item!!)
    b. Talk to "individuals" in a group

4. Things to avoid
    a. Conflict
    b. Distraction

5. Ask yourself why you are the one giving the presentation

6. What is the "objective" of your presentation
    a. Establish a central theme and stick to it
        i. Repeat it through the presentation
    b. Design your last visuals (your close) first!

7. Using color in a PowerPoint presentation
    a. Choice of color is important
        i. Blue is color of thinking, calming, etc. and is a good background color
            1. Yellow text on a blue background works well

8. Stick with standard fonts
    a. Times New Roman, Arial, Courier

**Increasing Useful Daylight: Promising Systems & Technological Challenges**
***Speaker***
Marilyne Andersen, PhD - *Assistant Professor of Building Technology*

1. Design blind profile to reduce glare
2. Maximize visible light
3. Reduce overheating risk but take advantage of solar gains
4. Reduce electric lighting
5. Provide glazing to allow daylight at summer and daylight and solar gain in winter
6. Need to let in a little bit of daylight for internal clocks
7. Acrylic with parallel cuts redirects big percent of light towards ceiling and small percentage in direction from sun.
8. Theoretical angular selective glazing could achieve more light deeper into space.
9. Parabolic mirrors help direct light deep into room
10. Often a prism panel could create color separation, not desired.
11. Genzyme HQ – Cambridge, MA provided good daylighting
12. 1% reduction of absentee or increased productivity will pay for increased building cost.
13. Adaptive shading controls is more adopted and will not yield over riding
14. If daylighting controls can work on diffuse part of sky then more predictable.
15. DOE categorized systems
16. www.d-lite.org
17. Daylight relative to comfort and energy

**Lamp & Ballast Update**
**Moderator**
Michael Lane, IESNA - *Project Manager*
**Panelists**
Paula Ziegenbein, IESNA, LC - *Applications Manager, Commercial Engineering*
Tom Harding, IESNA - *Vice President of Engineering*
John Wilson - *Product Manager*
Roy Sierleja, IESNA - *Fluorescent Product Specialist*

1. Mercury is hazardous and does not degrade. 1 gram is enough to contaminate a 1 acre lake.

2. Osram Sylvania's 'Eco-Logic' T8 lamp is high efficacy (91 lms/watt), long life, and lower mercury and lead.

3. Average mercury levels in a 4 foot T8 lamp have gone from 25 milligrams prior to 1995 to 6 milligrams in 2008.

4. A 32 watt T8 lamp may be replaced with a 25 watt lamp for energy savings. Light output is slightly lower. 2 foot and 3 foot are also available.

5. Always consider the application in which your lamp is running – particularly temperature.

6. The amalgam in T8VHO lamps allows full light output over a wider range in temperature.

7. General rule of thumb: 1 watt saved in a year equates to $1.

8. When programming occupancy sensors, keep in mind lamp life – optimal is ½ to 1 hour.

9. GE has a new screw base CFL lamp for residential use which has 3 available light outputs.

10. On average, office spaces are occupied 50% of the time.

11. Hi-efficiency fluorescent systems with bi-level dimming can double fluorescent lamp life.

12. OSRAM Sylvania offers a "Powershead" ballast which allows loadshedding by the utility at peak times.

13. Energy-saving T8 lamps may be dimmed, however they are sensitive to temperature and may have striations in the lamp when dimmed (purely asthetic

issue).

14. Halogen lamps can save 30-50% energy over incandescent.

15. As of January 2008, mercury vapor ballasts for general lighting may no longer be manufactured or imported.

16. Europe's ROHS-restriction of hazardous substances - has recently been adopted by California.

17. Ceramic metal halide lamps continue to improve with better color rendering for reds.

18. Osram Sylvania has a retrofit ceramic metal halide lamp with a screw base and integral ballast.

**Lighting Controls Solutions**

***Speaker***

Konstantinos Papamichael, PhD, IESNA - *Professor, Design Program; Associate Director, California Lighting Technology Center*

1. Market drivers for lighting controls include increasing energy cots, energy code, LEED, ASHRAE 189.P, and carbon reduction.

2. Per EPACT 2005 – S109, all Federal buildings are to be designed to LEED standards

3. Controls Case Study #1: Auto-on to 50%, Auto off saved 46% of energy.

4. Most people felt that 50% electrical light plus daylight from their windows was adequate.

5. Several people commented that they liked having their lights come on automatically.

6. For offices larger that 150 square feet, a ceiling mount occupancy sensor typically gives better coverage than an occupancy sensor switch.

7. In hotel rooms, a solution for turning off bathroom lights when not needed is to use a manual-on occupancy sensor switch set to one hour with an LED nightlight. This saves up to 75% of a hotel's lighting energy use.

8. For significant energy savings in commercial buildings, use an occupancy sensor in stairwells to turn on 50% of lights/lamps while the other 50% are unswitched.

9. For assisted living or hospital rooms, consider using a hybrid bi-level vanity fixture. The low-level lighting can be used as a nightlight and allows the occupant to see when returning to bed.

10. Set photocells to a 10 minute delay so that people's clothing does not affect dimming within the space.

11. Occupants prefer control and control saves energy when space is occupied.

12. Case study – auto on 50% with manual is 100% then auto off saved the most energy

**Lighting Mock-ups: The Lighting Designer's Most Powerful Tool**

***Speaker***

Randy Burkett, IESNA, FIALD, LC - *President & Design Principal*

1. Lighting mock-ups on almost all products to some scale

2. See something done well ok to recreate it

3. Renderings help at preliminary stages
    a. Computer simulation

4. Mock ups are one component of lighting design presentation
    a. Can be good for internal review as well as client review

5. Photoshop to illustrate
    a. Paint light with understanding how fixtures behave

6. Day & Night Photoshop rendering look good side by side

7. Similar application photos
    a. Photo library

8. Mock-ups
    a. Best way to show results
    b. Most illustrative method to present lighting
    c. Allows for clear comparison of options
    d. Permits design refinement
    e. Heightens client's confidence in design
    f. Demonstrates value of having a design professional involved
    g. Easy to see simple / quick changes
    h. Bring more fixtures than necessary to adapt to site conditions.

9. Must replicate what final result will do

10. Comparative techniques

11. Have different parts / pieces to do mock up efficiently

12. Can help with very subtle location and orientation options for specific fixture placement.

13. For exterior lighting be sure to categorize importance of various viewing angles/spots

14. Custom fixture mock-ups

15. Must document all findings (good and bad) from all mock ups
    a. Also should do this for final site observations when we see stuff we like and don't like
    b. Measurements
    c. Pictures

16. Mock ups required need to clearly show final results.

17. Mock up can help review/determine maintenance and re-lamping strategies.

18. Work with final system installers of walls, cabinetry, etc. to ensure final installation still has flexibility.

19. Where mock ups are required, this should be built into the design fee
    a. If mock up will occur during construction, make sure to indicate intent in plans/specs to ensure E.C. has this costs included in the bid.
    b. This even can be true for just "aiming"
    c. Note(s) should describe amount of time that the electrical contractor is to include, if lifts are required, and other anticipated requirements
    d. Note that it will occur at night and on an agreed upon date between the owner/ contractor/ designer.

20. Provide outline/handout with a simple explanation of what will be taking place & what the goals are
    a. This handout can also serve as an "agenda" for the process of the mock up.

21. Document Results
    a. Mock up checklist can help to avoid overlooking good info

**Magical Expression of History Through Lighting**
***Speaker***
Pedro Garza, IESNA, CAM, SAM, CEDIA, PLDA - *CEO*

1. Zacatecas Cathedral, Mexico
   The facade depicts 43 biblical stories from the Old Testament. Previously the tour guides were using a mirror like a laser pointer to point out the stories.
   Original lighting idea was to have an integrated touch-screen which controlled individual scenes and to add a commentary for each.

2. Morealia Cathedral, Mexico
   Lighting for the cathedral was finalized using metal halide lamps to flood the exterior. The lights are set up to come on top to bottom to reduce people from noticing the green tinge of the MH lamps as they come on.
   Every weekend starting Friday 500-200 people gather to see the lights and sounds as the fascade is laminated and narrated.

3. Dolores Hidalgo, Mexico
   This is the Cathedral where every 15$^{th}$ of September Mexico's independence is announced.
   There was a 5.1 surround sound system integrated into the square out front. There were also projectors integrated to allow images to be seen on the facade.

4. Xochicalco, Mexico
   A set of Teotihuacan pyramids named Xochicalco which translates to "The one who was". In researching the site it was found that the pyramids used to be covered in color. To relate to the theme these monuments were to be lighted using color-changing fixtures. For these people color played a large role in representation for tangible things found in their surroundings. Example: the correlation of yellow with the sun and corn, blue with water and sky. The idea was to use a multitude of varying color to create the story but not to have it look like Disneyland. The pricing for LED's was too expensive so instead the used eleven 2500W metal halide fixtures with color changing capabilities to flood the exterior of the structure. Each of the fixtures was customized out of molded rock to look as part of the architecture. There was also a 8mx6m water screen added to project a 21 min video story. As the story is being told, the color of the floodlights changes to match while hired or volunteer musicians add music to the ambiance.

**MEASUREMENTS**

1. Manufacturers measure lumen/watt by pulsating LED at 25 msec.

2. High current doesn't produce linear light output

3. Driver efficiency @ 90% is considered pretty good.

4. D.O.E. – Caliper program
    a. Luminaire is about 1/3 of LED performance
    b. 15 tested – 9 had overstated performance by 30 – 600%
    c. www.doe.netl.gov/ssl

5. Luminaire Efficiency
    a. LED typically higher than other lamps.
    b. More controlled
    c. Other requirements tell how to use aoniophotometer. Must use type C.
    d. Aoniophotometer to move around fixture, not move fixture. Creates irregular performance.

6. Drivers
    a. LED's need consistent source for consistent output.
    b. Different types of drivers for different conditions.
    c. Efficiency 75-90%
    d. PF = approx. 0.9 – 0.98
    e. Rating
        i. Efficiency – 90% at full load, 70% at partial load. * Must size drive to connected load

7. Reliability
    a. Heat
    b. Vibration
    c. Mechanical Stress
    d. Over/under voltage
    e. Environment
    f. Manufacturer quality
    g. Warranty 90 days on 10 years

8. Safety
    a. Grounding
    b. Short circuit / open circuit
    c. LED's wired series can produce high voltage – over 30 volt.
    d. 20 LED's at 3.4V=68V.

9. Controls
    a. Dimming can be linear and/or PWM

b. Balancing strings due to different Vf
c. Standards UL 1598 & 8750

10. Thermal
    a. Incan. Bulb heat goes out indirection of light
    b. Not true for LED's
    c. 90% of heat generate by LED's is conductive
    d. $ 5% radiation
        i. Whereas incan 90% radiation 5% conductive

    e. 350 mA good proportion of % of light out & % of heat generated

11. Lifetimes
    a. How to define lifetime defined as:
        i. 70% is end of life
        ii. Life is dependant on junction voltage
            1. 12K @ 1.5 hours
            2. 60k @ 0.35 hours
        iii. Standards
            1. IES LM-79
            2. IES LM-80
    b. Series of Trades
        i. Color – temps – lifetime
        ii. Flux – current – efficiency

12. Color
    a. Color shift over time due to phosphor drop.
    b. Color bin
        i. Can supplier consistently supply this color bin
        ii. Why more bins, can you see color shift between bins?

13. CRI
    a. CRI testing doesn't work for LED
        i. Reds come out brown
    b. Color limits

14. Inter changeability of LED diodes. Different manufacturers have different parameters.

**New Technologies for Integrating Lighting Controls with Energy Management Systems**

***Speaker***s

Doug Avery - *Project Manager*
Luís Fernandes, PhD - *Project Engineer*
Carlos Haiad - *Project Manager*

1. California – current and future demand exceeds power plant capacity
    a. Charge is to solve problems using demand side management and other renewable resources rather than adding power plants
    b. For reference, in California a typical weekday uses 23,300 MW peak demand
        i. A typical power plant is only 600 MW
    c. State buildings mandated to reduce energy usage by 20% by 2015
    d. 33% of total electricity sales from renewable sources by 2020.

2. To keep up with increasing energy demands, Southern California Edison is offering incentives to shed lighting loads during peak demand times.

3. The utility is encouraging the use of addressable ballasts to give building owners and occupants the opportunity to reduce lighting loads.

4. Title 24 2011 may make it a code that all ballasts that are available for sale must be addressable.

5. Southern California Edison is in the process of replacing standard utility meters with "smart meters" for communication and control capabilities.

6. Lighting accounts for approximately ¼ of California's electric energy use.

7. Case studies: occupants were happy with their automated lighting control system as long as they understood why their lights were dimming.

8. This presentation also talked about the potential for utility rates to increase/decrease throughout the day based upon load on the utility grid. This is where a smart thermostat could help manage the electrical consumption

**Visual Value of Light - Explaining the Financial Value of Great Lighting Design to Your Projects**

***Speaker***
Jonathan Speirs, PLDA, RIBA, ARIAS, Hon. FSLL FRSA - *Director*
Paul Gregory, IESNA - *President*

1. Some of the best projects happen when the designer is hired directly by the end user or client, not the architect. If you end-user hires the lighting designer, then you will get better buy-in.

2. Lighting designers believe they are not respected, not given enough time. Designers need time to make great results. Need reward.

3. Raise status of lighting designer on design team. Typically lighting designer is the last one hired, well after major decisions have been made.

4. It is important that the Lighting Designers get involved as early as possible to ensure they are not being given the scraps of fees that are left.

5. Lighting can bring a 10X multiplier impact to projects.

6. The visual impact of light is greater than the finishes within the space (and cost less).

7. Lighting can help create an iconic status of a project.

8. "All you see is reflected light". Otherwise, you don't see the objects; you see the light bouncing off of the objects into your eye. Light makes you see the materials.

9. Push the concept for a more successful design.

10. Architecture adds value to property.

11. Nighttime shots are iconic.

12. Daylight produces different effects through different times of the day.

13. Different levels of lighting design
    a. Illuminating Engineering – Numbers (no design, very minimum fee)
    b. Basic Architectural Lighting Design – basic cutsheets/layout (simple design, low involvement, low fee)
    c. Enhanced Architectural Lighting Design (full design, major involvement, high fee)

    d. Art Lighting Design (big fee to make a statement)

14. Enhanced Architectural Lighting Design should have unlimited involvement
    a. Creative Process
    b. Common Vision
    c. Study Reflective Surfaces
    d. “First Looks”
    e. Details
    f. Involvement

15. Designs around the world should be better – “Bar has been raised”. People are expecting more.

16. If you get the concept right and everybody agrees, then the project will succeed.

17. Design Goals
    a. Designer need to deliver clients needs
    b. Try to incorporate clients desires
    c. Guarantee

18. Usual design teams role
    a. Should express architects visual image

19. Client’s aspiration
    a. Iconic Image
    b. Verbal Marketing
    c. Powerful Memories

20. Light brings people in – first sell.

21. Lighting designer test the concept.

22. Common vision
    a. Need to be project wide

**ZigBee: Addressing Energy Efficiency**
***Speaker***
Chairman Bob Heile - *Chairman*

*Q: What is Zigbee?*
*A: A method for electrical devices to communicate over a standard wireless network*

1. Lots of options for automated controls, but to us (AEDG) the greatest potential is for automated energy management

2. Devices can report to utility company to determine load profiles and optimize energy use in commercial/residential buildings
    a. Options can pop up to allow homeowner to set the thermostat back temporarily in high peak demand timeframes.
    b. Helps to more pro-actively manage your electrical consumption as a homeowner or commercial building owner to help reduce bill cost.
    c. 67% of average household utility bill is attributed to temperature control and lighting

3. Over 250 companies around the world are providing Zigbee products

4. For maintenance cost savings, data can be kept for the specific use of lamps/ballasts to help determine appropriate relamping and maintenance

5. Potential is huge for Hotel/Hospitality sector
    a. Both retrofit and new
        i. Battery operated devices such as thermostats, occupancy sensors, humidistats, etc.
    b. Facilities utilizing this technology have shown a 40% energy savings after installation