This report contains recommendations from the 2013 E3T Advanced Lighting Control Systems FlashTAG. The FlashTAG was convened to provide technical advice to support administration of a new BPA performance-based incentive for advanced lighting controls. The new incentive will pay $0.18 /kWh for the first year's energy savings from a lighting control retrofit, with baseline hours-of-use derived from a RTF (Regional Technical Forum) interview protocol, and post-installation annual energy use estimated from a report based on 2 weeks of monitoring. This report might be issued by a networked lighting control system. The main purpose of the TAG was to describe the requirements for the report of 2 weeks of post-installation energy use. The TAG concluded that a 2 week period is very short, and likely to produce an inaccurate estimate of annual energy savings. In addition, lighting control systems that are cost effective at present in the PNW tend to be relatively simple, and might not necessarily include online software to produce reports of energy use.

Appendices include background information about the FlashTAG; a list of FlashTAG members; presentation slides and transcripts of the questions and answers received and addressed during the Showcase presentation and the TAG discussion; and scoring results for four selected technologies.

E3T Advanced Lighting Control Systems Recommendations

The following recommendations were developed by the 2013 ALCS "FlashTAG" (Technical Advisory Group) in May of 2013 for the general topic of ALCS (including all 4 technologies above).

Topic: Advanced Lighting Control Systems (ALCS) for Indoor and Outdoor Commercial Applications, including Wireless

Definition: Advanced lighting control systems, using a combination of manual control stations, motion and daylight sensors, and programmable time-based functions, that provide easy access for monitoring, scheduling, and programmable control through centralized or networked systems, usually capable of being remotely accessed through the Internet.

Note: the BPA Lighting Calculator will provide a performance-based incentive for this technology in 2013.

Summary

The opportunity for lighting energy savings through controls is significant. However, systems must be:

- ***Designed properly***. With rapidly accelerating technology, most specifiers and designers are no longer able to design lighting controls without significant assistance from factory-trained sales agents. Consider requiring factory certification of sales agencies, and consider requiring completion of the Lighting Controls Association (LCA) series for engineers and specifiers.
- ***Installed properly***. Training such as the California Advanced Lighting Controls Training Program (CALCTP) or the National Advanced Lighting Controls Training Program (NALCTP) has proven it makes a significant difference, and a regional program (NWALCTP?) should be mandatory or highly encouraged for installers.
- ***Commissioned properly***. At present, the only "commissioners" of lighting should be factory trained – consider making "factory certified" a requirement for system start-up, programming and operator education.
- ***Evaluated for cost-effectiveness***. The most cost-effective applications available at the present time are outdoor, indoor parking, industrial high-bay and library lighting – large areas with continuous lighting and infrequent occupancy. In many indoor applications, it is difficult to justify installing a sophisticated control system on energy payback alone, partly because the great advances in luminaire efficiency and luminaire-level controls have reduced the potential savings from advanced centralized control systems considerably. Cost-effective controls may consist of a simple timer or controller for the lighting circuit(s) at the electrical panel.

Research Recommendations

- **Primary Research**
  - The TAG expressed some concern about the baseline being based on a survey in the BPA Lighting Calculator. If it has not already been done, it would be worthwhile doing some monitoring in a statistically significant number of facilities where a representative has filled out the survey to establish how accurate the method of using a survey is in determining the

baseline.

- See below at the bottom of the discussion on Incentives under Programmatic Recommendations for suggestions on research to determine streamlined models for estimating annual savings based on short-term monitoring. When analyzing data, it would be useful to monitor usage and savings by time of day, in addition to overall savings, to determine the value of this technology for reducing peak loads for purposes of regional planning.

- **Marketplace**
  - Streamlining monitoring is critical. While some systems provide monitoring and reporting capability, sub-meters are not expensive. If BPA chose a single product or provided a choice between a small number of smart sub-meters for customers to choose from to use for each system, that could help standardize reporting. Investigate the marketplace for cost-effective smart metering for electrical systems equipped for remote monitoring and data downloading via phone and/or the Internet.
  - If the online monitoring software for the meters is easy enough to access, it may even make sense to have BPA do the monitoring rather than having customers self-report. This takes away most possibilities of cheating. Some online software may offer an option of read-only access for BPA, which would be preferable to full access with system changes permitted.

- **Case Studies**
  - Collect information on existing installations. The main purpose is to identify potential problems, such as early failures, and their causes. Another value could be to provide examples for customers to learn from if they are considering a similar installation. Beware that because product designs are changing so rapidly, performance information gathered on a product in place more than one or two years will be generally useful for the purposes outlined above, but it is likely that the specific system may have evolved into a somewhat different system by that point. The intent is that these "case studies" will not include an in-depth analysis and reporting of each site, but rather a brief overview of approximately 25 installations in the region with lessons learned.
  - A key point in evaluating these installations will be to assess the value of the energy reporting produced by or about the system.
  - Consider compiling a list of complaints in order to identify trends (e.g. particular problem manufacturers).
  - This would be worthwhile even if it was just for internal use.

- **Secondary Research**

  Perform additional secondary research. We should gather the available research by the US DOE, California utilities, the California Lighting Technology Center (CLTC), the Lighting Research Center (LRC), etc., and summarize the relevant conclusions. The TAG was not aware, however, of an existing large body of research. The main program that is similar is a pilot at SMUD: ***https://www.smud.org/en/about-smud/news-media/news-releases/2013-02-28-Advanced-Lighting-Controls.htm***

  In particular, monitor the study being performed at CLTC to develop "Algorithms for Advanced Lighting Control and Energy Management" using multiple data streams, both local and remote. http://cltc.ucdavis.edu/content/view/1203/476/

Programmatic Recommendations

- **Incentive System**
  - The TAG came to a strong consensus that two weeks of post-installation monitoring is inadequate to get an accurate measure of performance on which to pay the incentive. Holidays, vacation time, seasons, weather and changes in system settings could all have a significant impact on such a short measurement period. For a sampling period less than a year, a mathematical equation, i.e. a "model", is needed to estimate the annual energy savings. Very short periods such as two weeks increase the complexity and the unreliability of the model. We discussed various levels of monitoring and modeling that could provide progressive levels of confidence in the results.
    - Two weeks of post-installation monitoring, with the savings multiplied by 26.
    - Two weeks of monitoring with a model to estimate savings over a year based on occupancy (holidays, vacation season, work schedules) and daylight (time of year, latitude, daylight savings or standard time, etc.)
    - Three months of monitoring in the spring or fall, multiplied by 4
    - A full year of monitoring
  - Comment on models: It is complicated and expensive to build a model to predict annual savings based on a few weeks of data. In order to provide input data for such a model, the energy savings must be disaggregated into separate categories such as timing, occupancy, daylighting, bi-level, etc. In order to disaggregate the data, a complicated monitoring protocol is needed. The final answer is still inherently subject to unexpected changes in user behavior or equipment malfunction after the brief M&V period is complete. If the site selects the 2 week M&V period, there may be gaming involved or anomalies such as holidays. In addition, no one on the TAG knew of an existing model that would adequately serve this purpose, so BPA would have to find or develop a model or a number of models and test and verify them to make sure they predict accurate savings.
  - The TAG agreed that a full year of monitoring is desirable, but acknowledged that withholding the entire incentive for a year would reduce the value of the incentive. However, holding back a portion of the incentive may encourage customers to keep the system running efficiently.
  - Therefore, since so little is known at this point about the actual performance, BPA should monitor for a full year, at least in the beginning of the program, at least at some sites. Pay most of the incentive – 80 to 90 percent – based on two (or four?) weeks of monitoring, apply models to predict annual savings, and continue monitoring for a year. At the end of the year pay the rest of the incentive based on actual measured savings. We agreed that taking back from the customer previously awarded incentives if the system does not perform up to expectations over the year would be problematic. Note that most advanced control systems provide quarterly reports of energy use during the first year, as part of the sales contract. These reports might be available to BPA with minimal effort. After an initial period of the program (about two years?), evaluate the results of the monitoring to determine the answers to these questions:
    - Can a convenient monitoring period be combined with a model to yield results accurate enough for calculating performance-based incentives?
    - Did the full year of monitoring add enough accuracy or added savings to make it worth monitoring for that long, or could a shorter period provide results that are "good enough"?

- **Baseline:** Consider using the baseline protocol established by the Regional Technical Forum (http://rtf.nwcouncil.org/subcommittees/comlighting/). If the survey method in the Lighting Calculator is not consistent with that, consider making it so.
- Develop a protocol to allow continued commissioning, troubleshooting, or repeated measurement if initial monitoring shows poor performance. For example: If one two week period does not show savings that are credible, the customer may take another reading, but this time monitoring for four weeks.

- **Reporting**
  - Consider requiring a specific meter (or meters) and software so that energy use can be monitored by the utility, or at least provide a consistent report format. Consider using a particular smart sub-meter, or a particular datalogger with current transducer(s) to pick up the signals, such as the "WattNode" used by Southern California Edison. (http://www.microdaq.com/misc/404.php?zoom_query=wattnode&zoom_cat%5B%5D=-1).
  - Incentives should be based on a report of kWh for the entire system or sub-systems (per fixture is not necessary) for the entire monitoring period, and should be backed up by appropriate interval data – at least daily and preferably hourly or 15-minute data with a time stamp, to be able to verify that it is actual metered data. If provided by the customer (not read by BPA), require a specific format that will make it easy for BPA or the utility to interpret.

- **Implementation Considerations**
  - Vendor List: The TAG came to a consensus that maintaining a list of qualified vendors or products would be fraught with challenges, being difficult to keep up to date and inviting liability. While there may be some value in collecting a list of quality vendors and products internally, BPA should not offer to publish a list for public or utility use (unless there is a large resource commitment for development and ongoing maintenance of the list).
  - Instead of providing a vendor list, develop clear and simple specifications of what is required of the systems so that utilities and customers can do their own evaluations of the systems proposed.
  - Consider requiring commissioning in order to receive the incentive. Good standards are Design Guide 29, The Commissioning Process Applied to Lighting and Control Systems, by the Illuminating Engineering Society of North America (IES) and the lighting control section of ASHRAE Guideline 0-2005 -- The Commissioning Process . Also the California Energy Commission Title 24 Building Energy Efficiency Standards– 2013 Manual (soon to be published). Again, some felt that the structure of the incentive, being results-based, encourages commissioning to get better results, and that requiring this may not be necessary, but encouraging it should be part of the education and marketing process. If a requirement, maybe it should just be on larger projects -- over a threshold square footage. The TAG acknowledged that whatever system is put in place, it is in no one's interest to have poorly-performing systems installed, so efforts to encourage or require good performance are helpful. Consider adding a message somewhere in the lighting calculator to encourage commissioning.
  - Note that building codes are beginning to require sub-metering for sections of buildings or particular systems. This is already in the California code Title 24. This will help encourage customers to install sub-meters.

- **Education**

  Publish informational fact sheets, application and purchasing guidelines, and advice, and provide training for end-use customers, utility staff, contractors, specifiers, distributors and others. Target

audiences could include:

- ***Customers***
  - Develop an educational and training program in lighting controls for customers and end users.
  - Consider a requirement for ensuring a qualified operator will be available, preferably on-site.
- ***Utility staff***
  - The Lighting Controls Association courses (free online pre-requisites for NALCTP) should be required, or a similar but regionally-specific course developed by a qualified instructor.
- ***Contractors, specifiers and distributors***
  - Explore ways to encourage contractors to get training and certification such those offered by the Lighting Controls Association (LCA), similar to California Advanced Lighting Controls Training Program (CALCTP). Could you require training to qualify for the incentives or increase the incentive if you have a trained installer? Maybe publish a list of certified contractors. The TAG felt strongly that training should be encouraged, but some members felt that since the incentive is based on measured savings, the incentive to do a quality installation is already built into the program.
  - Regional training opportunities are needed. Because they are more cost-effective, focus mainly on exterior retrofits, plus maybe a little interior, and especially new construction and major renovations. Options include:
    - Online pre-requisite courses for advanced NALCTP courses. That is, Lighting Controls Association modules EE101, EE102 Part 1, EE103, and EE201 (Approximately 10 hours) http://aboutlightingcontrols.org/Education_Express/current.php
    - Consider requiring full NALCTP (CA, WA, etc.?) certification (https://www.nalctp.org/become-certified)
    - Evaluate the "Taking Control" or other courses offered by the Northwest Trade Ally Network (http://northwest-lighting.org/training). Are these good enough?
    - Develop a course something like SMUD's course taught by Steve Mesh (a two-day course). (https://usage.smud.org/etcstudent/ClassDescription.aspx?Id=801).

Product Availability

- We have found at least 68 manufacturers that manufacture some kind of lighting controls. A list of 11 manufacturers that have been certified by SMUD is available at https://www.smud.org/en/business/save-energy/rebates-incentives-financing/lighting/documents/ALC-qualified-product-list.pdf .
- The TAG felt that using the SMUD list directly would not be wise. It may or may not be up to date, and some of the companies may be local to California.