Very Efficacious: Transforming the Market with the DesignLights Consortium® Qualified Products List

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With more than 25,000 distinct products from more than 300 manufacturers, the DesignLights Consortium (DLC) Qualified Products List (QPL) is an essential database of commercial LED products for use in efficiency programs. The DLC is a project of Northeast Energy Efficiency Partnerships, a regional non-profit, and DLC members include federal agencies, state agencies, utilities, and energy efficiency programs. The DLC responds to the needs of its members by routinely updating its technical requirements and expanding into new lighting applications.

This poster presents trends in the performance of products submitted for qualification since the beginning of the program in 2009. Over the course of the program, the efficacy of qualified products has improved steadily in nearly all product categories. For example, the average outdoor LED product submitted in the first quarter of 2013 is 20% more efficacious than the average outdoor LED product submitted in the first quarter of 2011. The average indoor LED product has become 30% more efficacious over the same period. Because the QPL presents the worst-case performance of its qualified products, the overall improvement in the market is even more impressive.

In addition to these general trends, the poster also shows efficacy trends among some of the commercial market's most important lighting categories, including the following:

- Outdoor area lighting
- Refrigerated case lighting
- Indoor ambient lighting
- High-bay and low-bay lighting
- Retrofit kits

For each of these categories, we compare the performance of DLC-qualified products with the larger population of products in the U.S. Department of Energy's LED Lighting Facts database. We show how the DLC's specification revision process has kept pace with and, at times, driven improvements in the market at the high and low ends of product performance.

Based on the trends that can be observed in the QPL, the performance benchmarks used by utilities to measure deemed savings likely understate the actual savings values of commercial LED products. With an average of more than 900 new products added to the QPL every month, it is extremely important that energy efficiency programs understand these trends and adapt to the rapidly improving market for commercial LEDs.

Field Evaluation of Heat Pump Water Heaters in the Northeast

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Introduction

Program administrators in the Northeast have recently supported a number of residential pilot studies. One such study focused on quantifying the performance of heat pump water heaters (HPWH) installations. The purpose of this pilot was to better understand the real-world potential of this newly released residential water heating technology through in situ metering and analysis. Program administrators used the analysis developed in the study to screen HPWHs for cost-effectiveness in the northeast region, and to determine an appropriate incentive level to push the technology into the market.

Heat pump water heaters are primarily designed as replacements for traditional electric resistance water heaters and are able to achieve higher efficiencies through use of the vapor compression heat pump cycle. Auxiliary electric resistance elements are also installed for reliability and quicker hot water recovery. Most heat pumps operate as hybrid devices, meaning they use the heat pump whenever possible, but built-in controls switch to conventional resistance heating when there are large hot water needs.

Methods

This evaluation quantified the in-situ performance of three recently-released HPWH products for over one year. The evaluation aimed to answer questions about the optimal installation criteria of HPWHs in the Northeast, what is the expected water heating efficiencies of HPWHs installed in basements, how variables such as ambient temperature, temperature set points, and hot water demand affect HPWH performance, whether or not the examined models met the delivered hot water setpoint temperatures, and how satisfied homeowners were with the product.

Of the 14 units monitored, ten were General Electric GeoSpring™ models (50 gallon units), two were Stiebel Eltron Accelera®300 models (80 gallon units), and two were AO Smith Voltex® models (one 60 gallon and one 80 gallon unit). The sites were chosen in the residential markets of the sponsoring program administrators. Three of the homes had existing oil water heaters, one had a propane water heater, and the remaining were electric resistance water heaters (ERWHs). Though a small sample set, the overall performance of these 14 HPWHs has been enlightening and shows great promise for this technology.

Data collected on site included inlet and outlet water and air temperatures, hot water flow, as well as energy consumption of the compressor, heating element, and entire system. From the collected data, certain performance parameters were calculated for each installation. Performance parameters include average COPs and % time spent in electric resistance mode. Performance was examined with respect to water usage over time.

In order to determine how well HPWHs perform compared to other water heating systems, the evaluation also examined the utility bill savings for HPWHs over other fuel type systems. The other water heating systems included natural gas, fuel oil, and propane, each with various system efficiencies, and electric resistance heating. The cost of the various systems were also compiled and compared.

Findings

In general, these HPWHs were more than twice as efficient as a traditional electric resistance tank water heater; though there are large variations in overall efficiency as performance is dependent on ambient temperature/relative humidity, mains temperature, hot water setpoint temperature, and water usage (consumption and concentration).

Homeowners were generally satisfied with hot water delivery, efficiency, noise, and other characteristics. Ten out of the eleven survey respondents said that they would recommend a HPWH to a friend or family member. The one dissenting homeowner had issue with the noise of their HPWH as they had a home office in the room adjoining the basement mechanical room.

While HPWHs are a promising technology, installation and maintenance is slightly more complicated than a traditional electric resistance water heater. One of the potential installation issues with HPWHs is that they tend to be larger and heavier than traditional electric resistance tanks. The size may limit where the units can be installed. Another potential issue is that HPWHs extract heat from the surrounding air, so there is an impact on space conditioning loads that may need to be off-set by a heating system. The full extent of the space conditioning impact is still being researched. A "Selection and Quality Installation Guide" for HPWHs was developed for use in utility incentive programs to inform installers and home owners about proper maintenance and installation of HPWH units.

Is it Still Cost Effective to Promote Light Bulbs? Should We?

Seth Craigo-Snell, Director of Research, Applied Proactive Technologies, Inc.

Simply stated, program sponsors and regulators are unsure whether residential lighting programs should continue to promote CFLs given the change in standards brought about by the Energy Independence and Security Act of 2007 (EISA). Similarly, sponsors and regulators need to know if and when LED bulbs should be promoted. In this poster, we present an argument for the continued promotion of CFLs at least until 2020 and look also at the cost effectiveness of promoting LEDs over the same period and recommend targeted promotions for both.

In response to the EISA legislation, manufacturers have developed a new line of EISA compliant halogen (EC halogen) bulbs that are engineered to meet the EISA standards in each light output range (e.g. 72 watt EC halogen at 1490 lumens). These EC halogen bulbs, already available in the U.S. market, are the next generation baseline product for general purpose replacement lamps. A second tier standard was mandated by the EISA legislation to go into effect January 1, 2020 which requires that all general purpose lamps manufactured or imported into the U.S. market meet an efficacy of 45 lumens per watt.

U.S. lamp manufacturers anticipate EISA compliant halogen bulbs will gain significant market position beginning in 2015, and will quickly become the technology of choice for residential customers after the precipitous drop in incandescent bulb sales following the full phase in of the first tier EISA standards. Price estimates forecast a substantial drop in the prices of LED products (directional and omni-directional) reaching, on average, approximately $10/bulb for reflector LEDs and $5/bulb for A-Line LEDs by 2020. Standard incandescent bulbs are expected to hold steady at a very low cost per bulb while CFLs and EISA compliant halogen bulbs decrease steadily, but slowly. Based on this information from U.S. lamp manufacturers and the research of other in the EE industry (York, et. al., 2013; D&R, 2012; NEEP, 2012; EPA, 2011), EISA will not transform the residential lighting market on its own for many years to come.

Table 1: Gross Energy Savings Parameter Assumptions

PARAMETER	VALUE
Ave. Daily Operating Hours:	2.3 hrs/day
Rated Life of CFL:	10,000 hrs
Rated Life of LED:	25,000 hrs
Rated Life of Standard Incandescent/EISA Compliant Halogen:	1,000 hrs
CFL Ultimate Installation Rate (KEMA, 2010; p. 127, Table 77)**:**	0.973
LED Ultimate Installation Rate:	1.000

Table 2: Baseline Product Wattage Assumptions by Light Output (EPA, 2011)

Year	Light Output (lumens)				
	0-309	310-749	750-1049	1050-1489	1490-2600
2011 (pre-EISA)	25	39	59	73	97
2012	25	39	58	72	90
2013	25	37	55	64	80
2014	25	33	49	58	76
2015	25	33	49	58	76
2016	25	33	49	58	76
2017	25	33	49	58	76
2018	25	33	49	58	76
2019	25	33	49	58	76
2020 & after	25	12	20	28	45

Table 3: Net-to-Gross Ratios

Year	NTG	
	CFL	LED
2012	0.70	0.90
2013	0.67	0.86
2014	0.65	0.83
2015	0.62	0.80
2016	0.59	0.76
2017	0.57	0.73
2018	0.55	0.70
2019	0.53	0.68
2020	0.50	0.65

Table 4: Financial Estimates (Hornby, et. al., 2011)

Discount Rate:	**3.5%**
T&D Losses:	**7.0%**
Year	**Avoided Cost ($/kWh)**
2012	0.070615
2013	0.070968
2014	0.071323
2015	0.071680
2016	0.072038
2017	0.072398
2018	0.072760
2019	0.073124

Table 5: Promotional Costs

Year	CFL			LED-Reflector			LED-ALine		
	Incent	Admin	Total	Incent	Admin	Total	Incent	Admin	Total
2012	$1.35	$0.517	$1.87	$10.00	$0.517	$10.52	$10.00	$0.517	$10.52
2013	$1.35	$0.517	$1.87	$10.00	$0.517	$10.52	$8.00	$0.517	$8.52
2014	$1.35	$0.517	$1.87	$8.00	$0.517	$8.52	$6.00	$0.517	$6.52
2015	$1.35	$0.517	$1.87	$7.00	$0.517	$7.52	$5.00	$0.517	$5.52
2016	$1.35	$0.517	$1.87	$7.00	$0.517	$7.52	$5.00	$0.517	$5.52
2017	$1.35	$0.517	$1.87	$6.00	$0.517	$6.52	$5.00	$0.517	$5.52
2018	$1.35	$0.517	$1.87	$6.00	$0.517	$6.52	$4.00	$0.517	$4.52
2019	$1.35	$0.517	$1.87	$5.00	$0.517	$5.52	$4.00	$0.517	$4.52
2020 & after	$1.35	$0.517	$1.87	$5.00	$0.517	$5.52	$3.00	$0.517	$3.52

The analysis (*see poster for exact results*) demonstrates that both CFLs and LEDs can be cost effectively promoted at retail in the U.S. residential sector throughout this decade and beyond. In short, the answers to the questions asked in this poster are: **YES, it is,** and **YES, we should.**

For a more detailed discussion of the analysis and results please see:
http://www.appliedproactive.com/uploads/pdf/Craigo-Snell_IEPEC2013_PosterWrite-up.pdf

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IS IT STILL COST EFFECTIVE TO PROMOTE LIGHT BULBS? SHOULD WE?

Seth Craigo-Snell, Applied Proactive Technologies, Inc.

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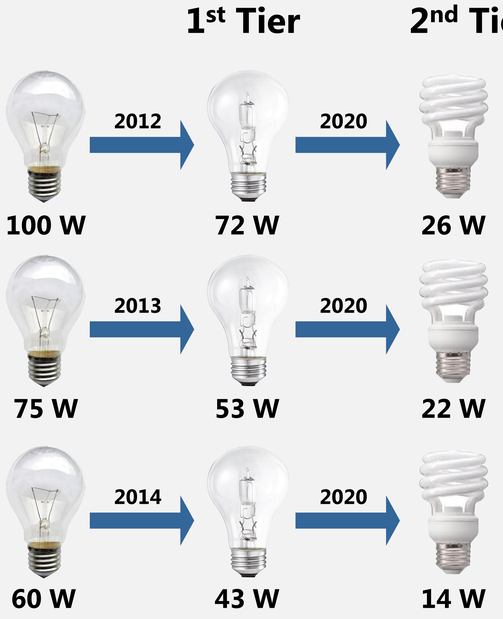
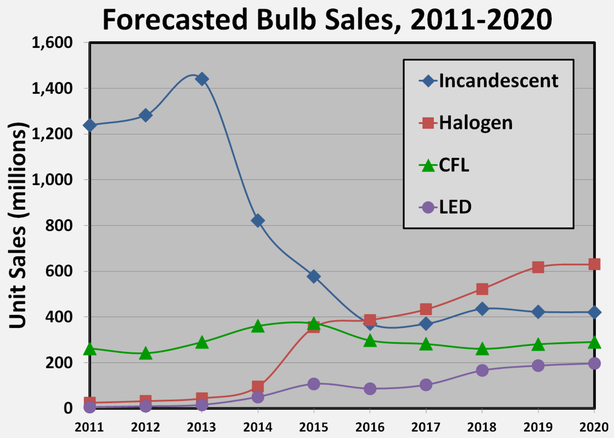
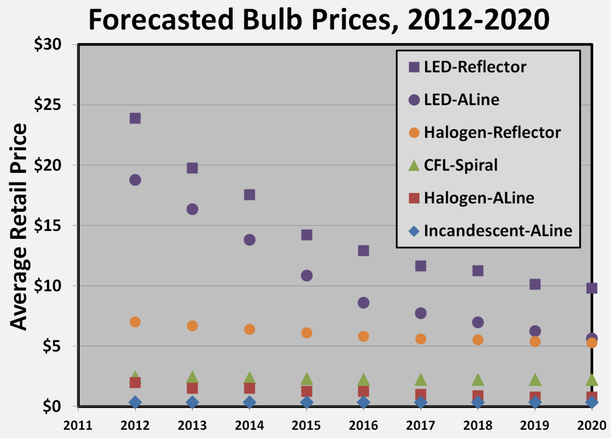
BASELINE CHANGES

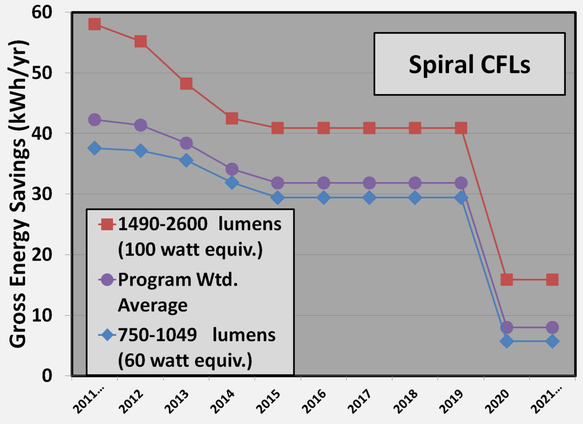


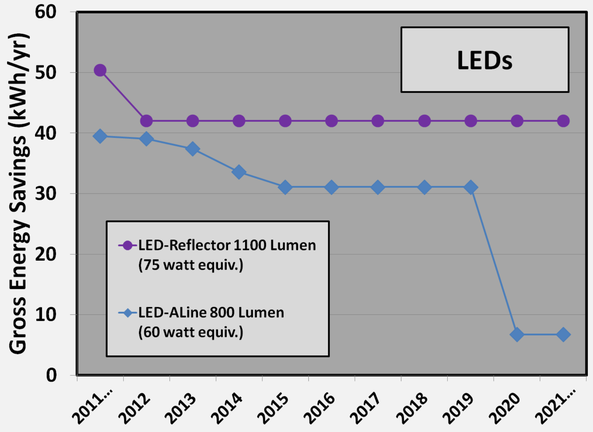
Where the market is headed …



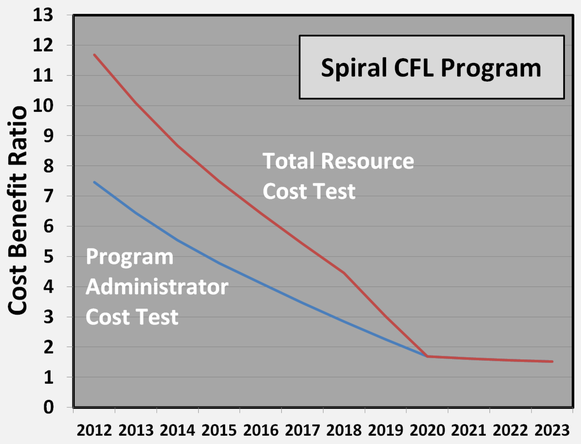


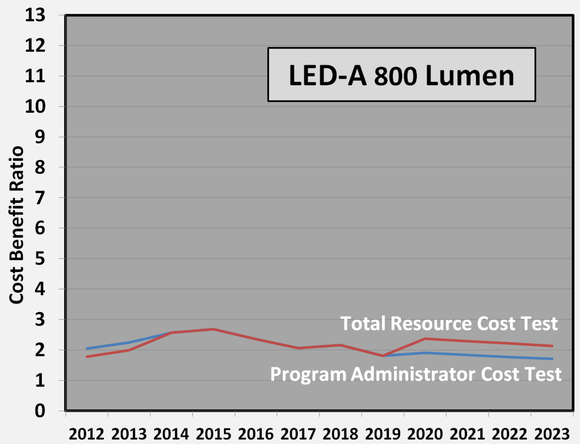
Savings …





Cost Effectiveness …





So ….

the answers?

YES, it is.

and

YES, we should.

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Determining Emissions from Electric Vehicle Adoption in Colorado

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Jennifer Detlor, University of Wisconsin at Madison
Jana Milford, University of Colorado at Boulder

Introduction

In the last few decades, there has been a push to discover and develop new transportation technologies that are both more efficient and less harmful for our environment. These advances have been made with the goal that the operation of the vehicle must release less pollution. Now the question is if the full life cycle of these vehicles are truly less harmful to the environment than the life cycle of internal combustion engine vehicles. Studies have been conducted throughout different regions of the United States to determine the emissions of various types of alternative vehicles. Elgowainy et al. (2010) found that regional electricity generation for battery recharging significantly impacts the energy use and green house gas (GHG) emissions.

Our research is part of a larger project called Project FEVER (Fostering Electric Vehicle Expansion in the Rockies). Project FEVER's main objective is to create a plan to increase the adoption of electric vehicles and electric vehicle equipment across Colorado. Through research and analysis, the project will identify barriers to EV penetration and develop strategies to overcome these barriers in the five issue areas of regulation, permitting, planning, policy, and outreach.

Approach

Our research is focused on the air quality impacts of electric vehicle (EV) penetration in Colorado. It demonstrates emissions released in a simulated 2020 Colorado for 16 different electricity generation scenarios, including our most aggressive scenario of replacing light duty gasoline vehicles with a 10% penetration of EVs. This projection will include assumptions about Colorado's future development of electricity generation and light duty vehicles. The year 2020 was chosen for this projection to allow a reasonable timeframe for the integration of EVs. EVs were chosen because they have the potential to reduce transportation-related air pollution. They release no air pollutant emissions during operation, but emissions do occur from the electricity generation needed to charge the EV. The air pollutant emissions our research focuses on include nitrogen oxides, sulfur oxides, ozone, particulate matter, and volatile organic compounds.

This study uses well-to-wheels life cycle assessment to compare the energy use and emissions of light duty gasoline vehicles with those of EVs that could be in use in Colorado in the year 2020. The well-to-wheels analysis considers energy use and emissions from the stages of production or extraction of the feedstock for vehicle fuel, fuel processing, fuel transport and distribution, and vehicle operation. For gasoline vehicles, this means accounting for impacts of crude oil extraction and refining, delivery of gasoline to the gas station, vehicle refueling, and gasoline consumption in the vehicle. For EVs, the well to-wheels assessment accounts for extraction and transport of natural gas, coal or other fuels used to generate electricity, electricity production, and transmission and distribution of electricity to the vehicle charging station. For plug-in hybrid electric vehicles, both gasoline and electricity pathways are considered. The well-to-wheels life cycle assessment was conducted using Argonne National Laboratory's Greenhouse Gases, Regulated Emissions and Energy Use in Transportation (GREET) model, with key inputs tailored for Colorado in the year 2020.

Methods

As noted above, previous studies have found that the mix of generating plants used to provide electricity for EV charging is a critical factor in determining how net EV emissions compare to those from gasoline vehicles. To address that factor, detailed unit commitment and dispatch modeling was performed for the projected electric power sector in Colorado in 2020. Dispatch modeling uses a least-cost approach to determine which generating units will be used to meet electricity demand on an hour-by-hour basis. We used the PLEXOS dispatch model with projections from the Western Electricity Coordinating Council (WECC) for the composition and characteristics of the generating fleet available to serve Colorado customers in 2020 and their forecast hourly demand for electricity. The WECC projection of the power plant fleet was altered to reflect current plans for power plant fuel switching and shutdowns and Colorado's renewable portfolio standards.

Results

Results of this study projecting emissions changes for GHG and air pollutants will be released to local governments and other parties of interest. It should be noted that the actual electricity generation used for recharging EVs could be significantly different depending on actual penetration of EVs over time, impact of policy development, impact of future fuel prices, and impact on number of chargers per day.

Forecasting the Energy Impacts of State Energy-Efficiency Policies

Nikolaas J. Dietsch & Robyn K. DeYoung, U.S. Environmental Protection Agency (EPA)

Introduction

States and municipalities in "non-attainment" for one or more air pollutants regulated under the National Ambient Air Quality Standards (NAAQS) are required to submit State Implementation Plans (SIPs) to the U.S. Environmental Protection Agency (EPA) that describe how they will attain the NAAQS by a specified data. To help these jurisdictions capture the benefits of energy efficiency policies in SIPs, EPA has developed a draft methodology for estimating the energy impacts of key EE/RE "on the books" policies that are not explicitly reflected in the Energy Information Administration's (EIA) Annual Energy Outlook (AEO) 2013 electricity projections. These policies include energy efficiency resource standards (EERS) and dedicated sources of EE program funding that are adopted in state law and/or codified in rule or order. EPA then used this methodology to develop projected estimates of the energy impacts of EE/RE policies not accounted for in the AEO2013 forecast for the period 2013-2030. This poster will describe EPA's methodology and present state-by-state energy and demand impacts. More information is available at: http://www.epa.gov/statelocalclimate/state/statepolicies.html

At Variance: The Cluster Sampling Paradigm

Geoffrey Embree, Northeast Utilities

Summary

Many energy efficiency evaluations examine multiple measure installations per site, but treat that site as a single observation for purposes of estimating variance. Rather than treating each site as an individual observation, cluster sampling treats each independently evaluated measure as a separate data point, reducing the variance of the final estimate. In the past, strong intra-cluster correlation has limited the effectiveness of a clustered approach, but as CFLs and other technologies have become more mainstream, cluster sampling may more accurately represent the margin of error in a typical saturation study or home energy audit, and explains the impressive stability of these estimates in recent years.

This poster presents some simple calculations for a model lighting saturation study supporting an actual variance equal to approximately half of the per-site variance estimate, implying an effective sample size equal to four times the number of sites. Evaluations are already realizing the benefit of cluster sampling approaches – the only thing left is to quantify the improvement and convey to end-users the enhanced precision delivered by comprehensive site visits.

Changes of Energy Saving Behavior Since the Earthquake in Japan

Goshi Fujimoto, Tokyo Gas Co., Ltd.
Yumiko Iwafune, The University of Tokyo

Introduction

We analyzed the structure of energy savings based on wide scale questionnaire surveys with around 5,000 sample sizes since the Great East Japan Earthquake 2011 in Japan. People in Japan have been focusing on how to effectively conserve energy, especially electricity. This is the innovative approach for understanding the changes of human behavior for energy consumption because any verification tests have never attempted in such a wide and long scale even in the world.

This poster addresses the issue if energy saving behavior on residential sector could be achieved or not. We found that 7-10% electricity saving with correlating energy usage with air temperature in Kanto area around Tokyo was achieved on summer and winter in 2011 from questionnaire surveys. In addition, even in one year after the earthquake, that is, summer in 2012, survey result clarifies that people could save a little more electricity compared to the level of 2011. Why could people achieve? Which actions could they take? Beside such simple questions, it is not still obvious, which actions contributed to electricity demand reduction, as well as which actions would be continuous in the future. Quantifying the contribution ratio of each action to the energy saving amount is also our target to be clarified.

Analysis Approach

This research aims to get a solution by applying multivariable analysis to the result of web-based questionnaire surveys. We conducted 3 times surveys to find out what happened to people concerning energy saving behavior since the earthquake, and developed multi regression model explaining the reduction of electricity demand in 2011 and 2012 compared to the previous years as an objective variable. In order to collect the electricity usage of each sample as an objective variable, we obtained the billing receipt from 2010 to 2012. In addition we investigated the implementation of energy saving actions such as changes of setting temperature and usage hours of air conditioner (AC), disposal/purchase/replacement of appliances, and the degree of any other energy saving actions.

Results

As the most effective actions, the replacement of appliances which consume large electricity amount was dominant because efficiencies of such appliances have been improved drastically. The implementation ratios of replacement behaviors, however, are low because people usually don't purchase a new appliance unless it would break down. Even if these replacement actions are effective for energy saving, it cannot be seen as recommendable actions for everyone. In contrast, as easier actions to implement, small actions such as reducing usage hour for AC, electric heaters, and heating appliances like rice cooker, closing doors when ACs are working, and setting the temperature of refrigerator low, are extracted as easier actions to be taken. Due to the consideration under both of the effect and the implemental rate of electricity saving actions, we clarified the replacement of LED, which occupied around 10% contribution ratio to the total energy saving volume, and the reduction of used hours of AC or heaters, which occupied around 30% contribution ratio, are effective and continuous most.

Retrofitting Multifamily Buildings: A Sustainable Model for Energy Savings

Marjorie A Isaacson, CNT Energy; Peter Ludwig, CNT Energy

Introduction

Energy efficiency upgrades in multifamily residential buildings could save building owners and residents up to $3.4 billion and reduce energy use and greenhouse gas emissions significantly. However, this market is both underserved by utility energy efficiency programs, which traditionally focus on the single family market; and difficult to serve due to barriers faced by building owners. These barriers include obtaining accurate information about effective measures, difficulty in finding qualified contractors, and access to financing. The impact of high energy costs is especially acute in low/moderate income housing, where higher energy prices can increase operating expenses to the extent that this housing is no longer affordable.

The Program Design

This poster presents CNT Energy's residential retrofit program, which has evaluated and rehabbed over 12,000 multifamily housing units, achieving natural gas savings of more than 3,034,320 therms, electricity saving of more than 8,217,950 kilowatt hours, and 17,607 metric tons of CO2. A key component of the program's success is collaboration with a mortgage lender. This combination of technical assistance and financing offers building owners a one-stop shop solution for installing energy efficiency upgrades.

The program design includes verification of energy savings by utility bill analysis. Baseline energy use is calculated pre-retrofit, then monitored for two years following the measure installation. If projected energy savings (estimated from the measures that were installed) are not achieved, CNT Energy performs a "tune-up" to investigate possible causes for the discrepancy and facilitate solutions.

Findings

The energy savings of the retrofit buildings were recently verified by an independent third-party reviewer. This study found that on average, buildings that completed energy efficiency upgrades through the program saved 20 percent on natural gas use, with savings increasing to 26 percent during the heating season months of November through March, measured against comparable buildings that did not make efficiency improvements. The process of verifying metrics is emerging as a priority as Chicago establishes building performance benchmarking.

CNT Energy's program is grounded in technical assistance, including building assessment, construction management, oversight, and coordination of utility rebates. It also requires expertise in softer skills. For example, a prerequisite for a successful program is buy-in by building owners. An ongoing program challenge is to convince building owners to invest in work such as air sealing and insulation, as opposed to more visible and cosmetically appealing improvements such as new window installation. Other upgrades have a social engineering aspect; i.e. retraining the maintenance staff to use new temperature monitoring equipment to balance a building's steam heat, instead of overheating to prevent resident complaints.

The CNT Energy multifamily retrofit program is a proven and sustainable model for performance-based energy efficiency programs.

Assessing New Construction Programs in Light of Advancing Standards: Where are the Opportunities for Deeper Savings?

Jim Leahy, DNV KEMA, Burlington, MA;
Wendy Todd, National Grid, Waltham, MA

Introduction

The new construction market has evolved dramatically in recent years. The rapid changes in building energy efficiency codes combined with market expectations for greener, more efficient buildings has resulted in energy efficiency programs finding fewer savings opportunities to deliver upon.

Green building certification programs such as the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) program, and the increasing stringency of the ASHRAE 90.1 standard and IECC code, as well as the overall availability of energy efficient equipment in the market, have lead architects, engineers and contractors to re-examine and improve their design and specification practices. They have had to learn and accept new design strategies, think in different or more creative ways, and ultimately adapt to meet market demand for energy efficient design.

This poster presents the perspective of supply-side market actors in Massachusetts on challenges and opportunities in the new construction market based on in-depth interviews with 31 architects, 11 mechanical engineers and 9 construction managers. The research team consisted of personnel experienced in building science and the new construction which allowed and the team to explore and understand the market issues more in-depth.

The goals of the study were to:

1. Characterize the design, engineering, and construction management firms involved with recent large commercial construction projects.
2. Characterize the design and specification practices with regard to energy efficiency.
3. Assess awareness and participation in new construction programs offered by the Energy Efficiency Program Administrators.
4. Assess changes in design and specification practices as a result of contact with the new construction programs.

In conducting the research, the research team developed the sample based on F.W. Dodge new construction market data from 2005 through 2010, and interviewed architects, engineers, and construction managers who represented firms of different sizes based on total construction value, and then analyzed the results of those interviews.

Findings and Conclusions

Key findings of the research in relation to market actor general practices, program awareness, the impact of energy codes, and equipment included:

1. Building professionals continue to face obstacles in designing and specifying energy efficient equipment including:

    - First costs
    - Diverse decision making practices
    - Reluctance to change established methods
    - Convincing clients to use unfamiliar technologies
    - Resistance to train personnel to use more complicated systems
    - Lead times, product availability, and constructability

2. Most respondents claimed to have only modest knowledge of the utility incentive programs, indicated that the time it takes to coordinate and apply for incentives can be a deterrent and that the time at which the utilities are engaged is generally inconsistent and leads to mixed results.

3. Equipment seemed to be keeping up with energy code changes; however some designers find themselves in a constant learning curve because of the rapid pace of changes to codes.

4. In relation to specific types of equipment –

Lighting:

- Strong interest in LED lighting fixtures presents good opportunities for additional savings
- While occupancy sensors are fairly common, daylight dimmers remain at a premium are generally not specified

HVAC:

- Variable Air Volume HVAC systems are becoming common practice.
- Evaporative condensing units, chilled beams, and co-generation systems are gaining wider acceptance
- While the benefits of advanced controls, monitors, and sensors are well recognized, some engineers are view these systems as more problematic than helpful

Envelope:

- According to the responses there is a general lack of understanding amongst design professions of what constitutes an energy efficient wall or roof assembly

Building Simulation Modeling:

- Opportunities to fully engage design teams with Comprehensive Design Assistance are lost when building simulation models cannot be obtained quickly enough to affect efficient equipment and measure selection.

Building Commissioning:

- While building commissioning was highly regarded, this effect of commissioning on operations is unclear making the cost of commissioning difficult to justify to building owners.

The Extra Mile: Searching for Indirect Market Effects?

Lori Lewis, Ph.D., Δnalytical ∑valuation □onsultants, LLC.
Kathryn Parlin, West Hill Energy and Computing, Inc.[1]

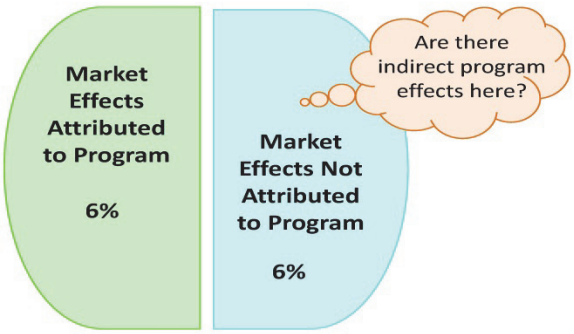
Introduction

An ongoing challenge in estimating program-related savings is that program impacts may be entirely invisible to the market actors. While some efficiency programs may well be designed to increase the availability of efficiency products and improve the efficiency of construction practices, the ripple effects from these program activities may not be associated by market actors with the efficiency program.

This poster presents an overview of an evaluation that was designed to estimate non-participant spillover (NPSO) and also included an initial pilot effort to quantify indirect market effects. This work was part of an impact evaluation of the New York State Energy and Research Development Authority's (NYSERDA) commercial New Construction Program (NCP). To estimate market effects and NPSO, telephone surveys of non-participating design team members (architects, engineers and contractors) were conducted.

The primary basis for estimating both NPSO and market effects was the market penetration gains by measure as reported by the non-participating design teams, as this estimate provided the upper bound for potential program-related savings. The NPSO savings were defined as the portion of the market penetration gains attributed directly to the program by the design teams. Evaluators then assessed whether there could be program activities that were unknown to the design team members.

Figure 1. Is There a Portion of Market Change Due to Invisible Program Effects?

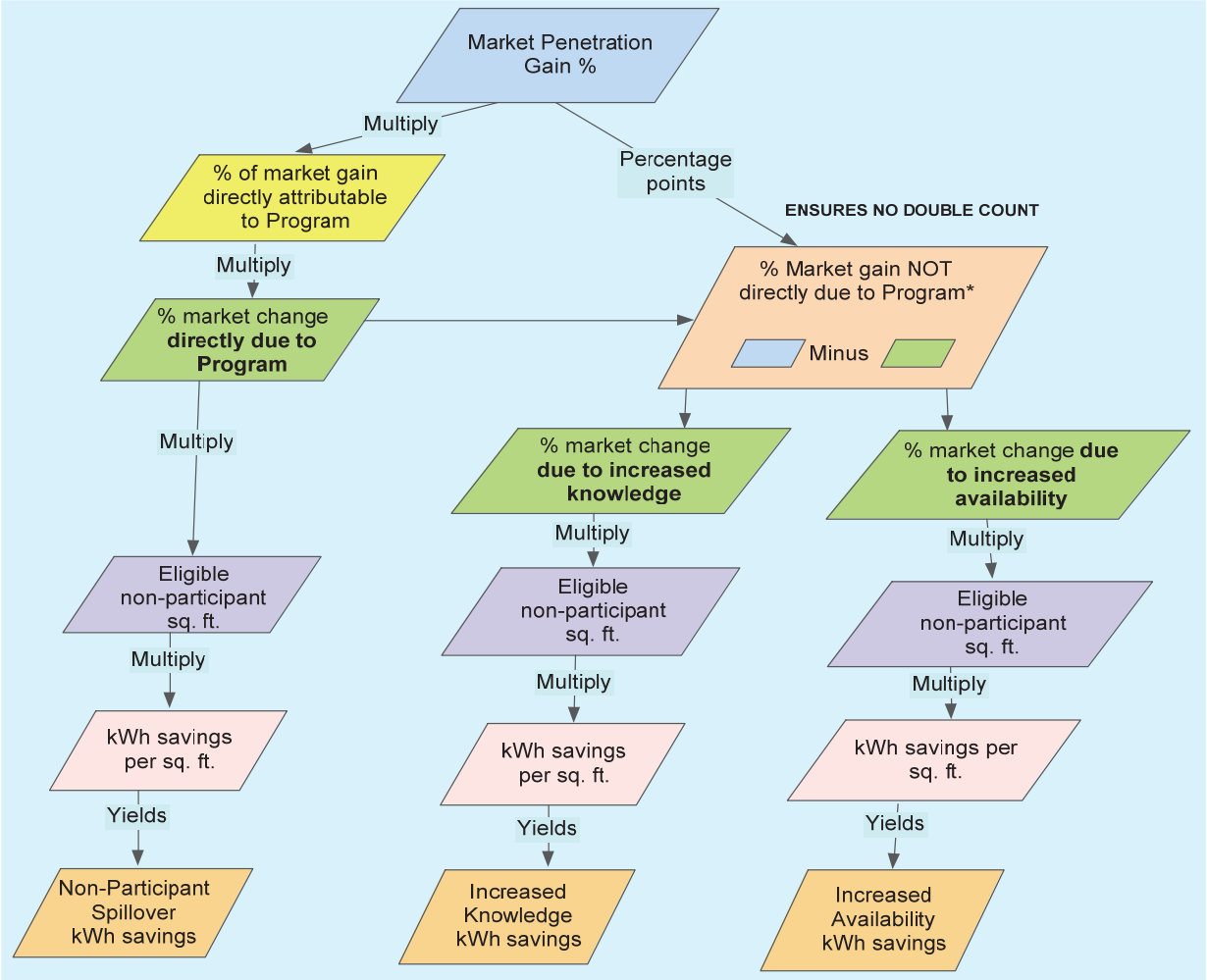


The next question, as illustrated in Figure 1, was whether any of the remaining improvement in efficiency could also be associated with the program. Survey respondents were asked to the assess the relative importance of eight factors that may influence the adoption of energy efficient technologies and practices, such as higher energy prices, increased availability of high efficiency products, increased knowledge of efficient construction practices, and awareness of environmental consequences of energy use. Of these eight influential factors, two were identified as related to NYSERDA program activity through a review of the program logic models: increased availability of efficient products and improved knowledge of efficient construction practices. Further analysis was used to quantify the savings that

[1] We wish to thank Jennifer Meissner (NYSERDA) for the initial issues and concept discussions that were the genesis for this work. That brainstorming enabled the pilot study to be designed and undertaken.

could be related to program activities. An overview of the method is shown on the poster and included here as Figure 2.

Figure 2. Overview of NPSO and Indirect Market Effects Method



The indirect market effects were estimated as 22% of the program impact.

The poster considers several overarching questions about how to improve estimates indirect program-induced market effects and explores whether an acceptable method to attribute savings from these indirect effects to the program will allow them be valued in regulatory and policy venues.

Searching for Indirect Market Effects?

Lori Lewis
Steve Doyle

Lori Lewis, Ph.D., Δnalytical ∑valuation ¢onsultants, LLC.
Kathryn Parlin, West Hill Energy and Computing, Inc.

We wish to thank Jennifer Meissner (NYSERDA) for the initial issues and concept discussions that were the genesis for this work. That brainstorming enabled the pilot study to be designed and undertaken.

The views expressed in this poster are those of the authors and do not necessarily reflect the views of the New York State Energy Research and Development Authority (NYSERDA).

Commercial New Construction Program (New York State Energy Research and Development Authority (NYSERDA))

Impact Evaluation Non-Participant Spillover Analysis:

- Dodge new construction: Design teams of non-participating projects
- Design Team was asked about market penetration by measure currently and two years ago
- The difference between the two is the market change
- They were then asked what percentage of the market change could be attributed to the Program
- Percent of Influence * Market Change = NPSO estimate

Market Effects Attributed to Program

6%

Are there indirect program effects here?

Market Effects Not Attributed to Program

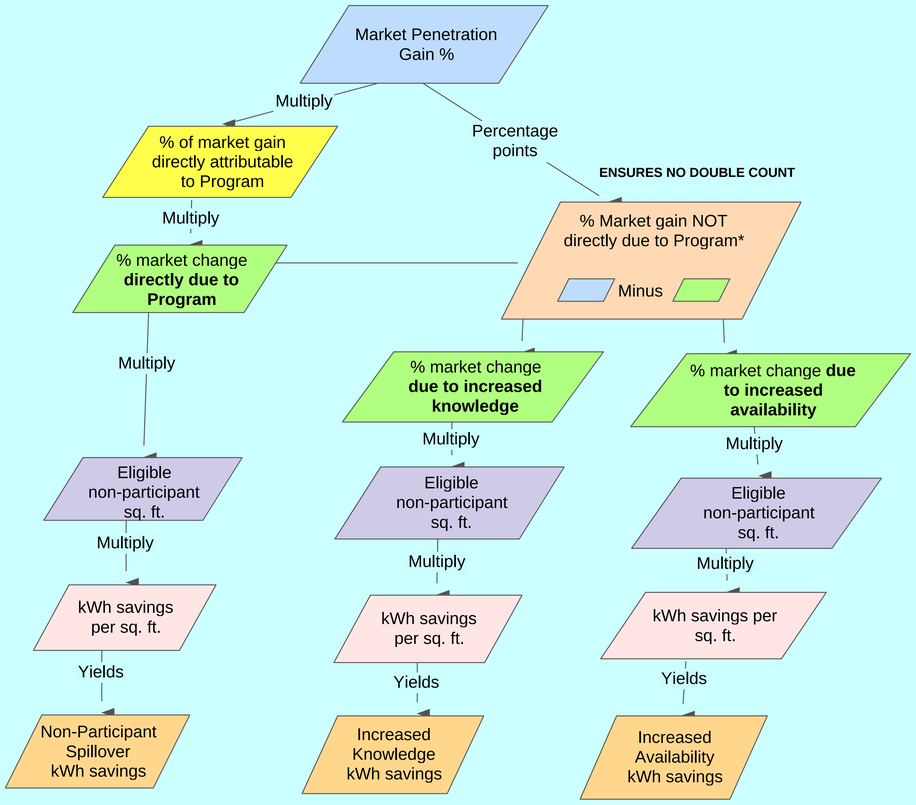
6%

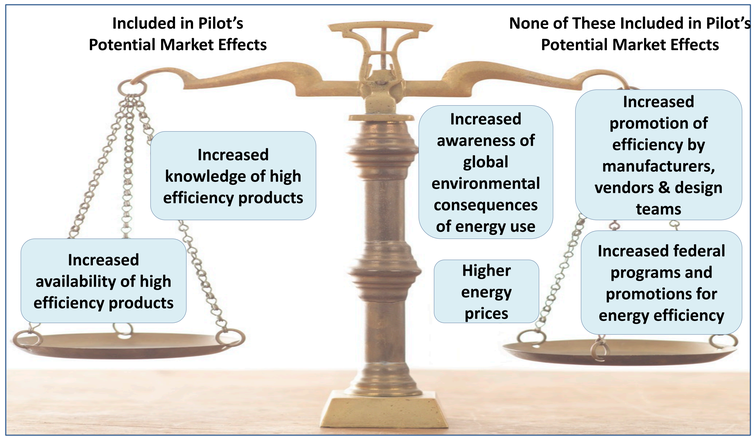
Extract from Program Logic Model

Program is designed to effect the market by changing the following:

- Knowledge of energy efficiency
- Availability of high efficiency measures and practices
- Promotion of energy efficiency by architects and engineering firms and retailers
- Behavior and decision-making regarding investing in high efficiency in new construction and major renovations

Estimating the Uncaptured Market Effects Potential

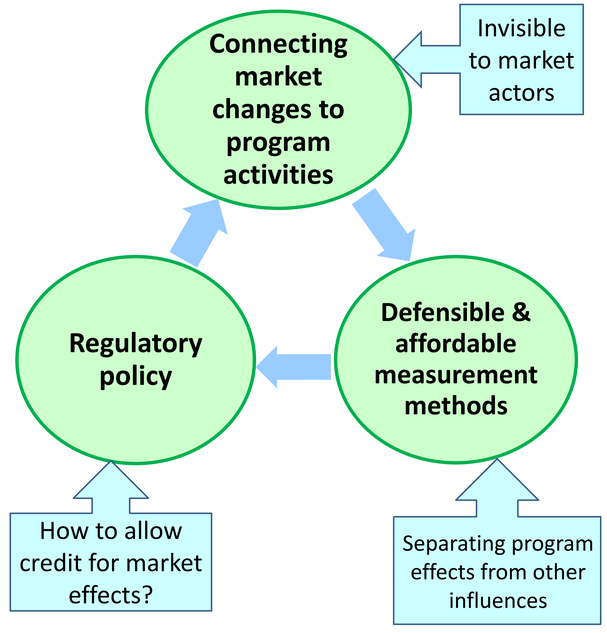




Uncaptured Market Effects = 17% of program savings

Key Questions:

- How are these potential savings related to the actions as defined in the program logic model and implemented by the program administrator?
- How can evaluators reasonably attribute savings to the program versus those that are due to other factors?
- Is there a defensible mechanism to measure these savings and allow the program administrator to claim them?
- If there is no method to attribute savings from these indirect effects to the program, can they still be valued in regulatory and policy venues?



Characterizing the Multifamily Market -- Lessons Learned and Best Practices

Jeannette LeZaks, Energy Center of Wisconsin
Tom Syring, Franklin Energy Services, LLC

Introduction

This poster presents the best practices and lessons learned from a field study which characterized the Minnesota multifamily rental housing market. The Minnesota Department of Commerce Division of Energy Resources funded this characterization with the objective of understanding the multifamily market more deeply since up until this time, no comprehensive characterization of the Minnesota multifamily housing market had been conducted. Our goals for the study were to provide a statistically representative picture of the building characteristics, appliances and equipment in the Minnesota rental housing stock and assess energy efficiency opportunities. We conducted walk-through audits for 120 multifamily properties with in-field monitoring in a limited number of buildings. In addition, we explored the knowledge, attitudes and behavior of building tenants, owners and managers through surveys.

Lessons Learned

Because the scope of this project was large and involved many moving parts, we thought it would be beneficial to present some of the challenges we faced in conducting a large-scale field-based characterization study and describe the lessons learned in hopes that others may apply what we garnered in future projects. We offer two overarching lessons learned followed by specific issues that we encountered.

Overarching Lessons Learned:

1) **Use a customer relationship management (CRM) system to track data from the very beginning of the project to organize and manage complex relationships.** The participant recruitment process can be complex and requires many touch-points from first calls to final follow-ups. Having a CRM system would provide the depth of data needed to manage and build the relationships for study recruitment.
2) **Use a tablet-based field data collection system to simplify data collection and data analysis.** While we did not use a tablet-based system, we felt that such tools available today offer a streamlined approach to capturing large amounts of data, both for data collection in the field and for analysis out of the field.

Building Participant Recruiting

Issue: Very low response to cold-calling via telephone. We seldom reached the decision maker in one call and the customers almost always asked for information to be sent. It was necessary to re-contact numerous times before answer received (yes or no)

Solutions: We found that we needed to approach recruitment from a number of angles, not simply through cold-calling:

a. Direct mail to introduce program (received some response)
b. Follow-up telephone call
c. Email information (person often missed postcard)
d. Follow-up telephone call (repeat until answer received)

Primary lesson: It was necessary to develop a relationship with the building owner or manager before most would agree to participate, which required many touch-points to recruit a participant.

Participant Site Visit Coordination

Issue: We encountered no shows for on-site data collection. Early on, building managers would schedule for representatives to meet the energy advisor. Several did not show.

Solution: Cell phone contact with the on-site representative must be made several days prior to the visit, and the day prior to the visit.

Primary lesson: More contact is always better, and contact with the person you are meeting is essential.

Tenant Participation

Issue: Needed to motivate tenant to respond to surveys and complete a utility release form. Since the utility release form was required to be in paper format, we also wanted to make it easy for tenants to send in the form in addition to filling out the survey.

Solution: We offered cash incentives to those tenants that sent in both a survey and their utility release form. We created a graphically pleasing cover-letter to motivate a tenant to pick up the survey packets.

Primary Lesson: Offer respondents multiple modes of providing feedback and make it easy to send the information back to us. We gave the option for submitting either online or paper surveys, but we still provided business-reply envelopes so they could simply drop the utility release form in the mail to send it back.

Field Data Collection

Issue: The data collection forms were complex and we asked the field technicians to fill out a lot of information in a little amount of time.

Solution: We accompanied the field technicians on site visits to ensure that data collection was thorough. However, recognize that since every building has its own quirks, there will be unforeseen challenges that may come up on other site visits.

Primary Lesson: Always conduct test walk-through audits to ensure everyone is on the same page. Be sure to highlight the prioritization of data collection and emphasize when to double check with analyst on questions on the field form. Oftentimes, this means more up-front planning than is typically allocated. And to reiterate an overarching lesson learned, a tablet-based data collection system would allow for simple and timely quality control of incoming data.

Will a Green Jobs Objective Help or Hinder the Achievement of Energy Savings Goals?

Lance Loncke, District Department of the Environment, Energy Administration, Washington DC
Teri Lutz, Tetra Tech, Madison, WI

Introduction

In recent years, green jobs objectives have realized an increased emphasis as a means to stimulate both short-term and sustainable job creation across North America. This is an understandable and valued intention as governments, policy makers, and citizens demand additional benefits from tax dollars spent on mandated energy efficiency and renewable energy programs designed to produce a more energy efficient economy. As one would expect, this demand receives increased scrutiny and expectations for localized job creation when coupled with rate-payer funding.

So…what happens when localized green jobs objectives are directly attached to energy and demand savings goals? Do they distract from cost-effective implementation efforts as implementers deploy resources to chase jobs rather than and/or in addition to pursuing energy savings? Does pursuing localized jobs increase or decrease cost effectiveness of energy programs? Are there short-term costs for this strategy that will be outweighed in the longer term? Will an early-on aggressive green jobs objective prove insightful and brilliant once programs become more mature?

The Harmony, or Dichotomy, of Objectives

In 2011, the District Department of the Environment, through the District of Columbia Sustainable Energy Utility (DC SEU), began implementing energy efficiency and renewable energy programs within the District. The DC SEU is charged with helping District households and businesses save energy and money through energy efficiency and renewable energy programs while increasing the number of green-collar jobs in the District. In addition, the DC SEU must implement a cost effective portfolio of energy efficiency programs, increase renewable energy generation capacity, and ensure 30 percent of expenditures support low-income housing efficiency programs on a year-by-year basis. Additionally, DDOE requires rigorous tracking, verification, and reporting of local resident green jobs directly resulting from the DC SEU expenditures, a unique District requirement. These objectives and requirements compete for money and labor, as well as for strategic and tactical planning for the development and delivery of the energy savings portfolio.

A Lot of Questions and Developing Answers

Full implementation efforts have been in operation for less than two years and the portfolio of programs offered by the DC SEU was first evaluated in the first quarter of 2013. Initial evaluation efforts, as well as early implementation efforts, are leading to more questions than quantifiable answers regarding the interplay between objectives. Although there are indications that the challenges of growing a local job force competes for resources and detracts from other portfolio goals early on, the questions for how these objectives will play out in the future remain open…and evaluation efforts will continue to assess the impacts of these objectives. Stay tuned…

Commercial New Construction Code Compliance; Strategies for Accurate Assessment and Improved Compliance Rates

Poster Authors: Brian McCowan (ERS), Gary Epstein (ERS), Ryan Barry (DNV/KEMA), Jim Leahy, (DNV/KEMA), Andrea Ranger (DNV/KEMA), Wendy Todd (National Grid)

Introduction

This poster presents the methodology and findings of a 2012 commercial construction baseline and code compliance study approximately 120 commercial buildings in Massachusetts and Rhode Island. The study included market actor interviews and the field evaluation of construction practices and equipment installation in relation to energy code mandates in the two states. The study was part of an ongoing evaluation effort of efficiency programs and served several purposes, including: determining code compliance rates as required for states accepting ARRA funding for energy efficiency efforts; updating baseline information for commercial new construction programs, gauging awareness of the Massachusetts Stretch Code and other "reach" codes, and establishing baselines and guidance for future energy code savings attribution.

Study methodologies employed included:

- Modification of the DOE/PNNL code compliance methodology recommended for ARRA mandated compliance verification for practicality, accuracy, and regional based impacts
- Development of an *iPad Filemaker* code compliance tool
- Development of custom spreadsheet to replace DOE/PNNL "Score & Store"
- Review of design documents for code compliance
- Site visits to verify and rate compliance
- Extensive interviewing of market actors and code officials
- Reporting of overall compliance rates and compliance by category

Conclusions resulting from the study include:

- Overall energy code compliance rates in the two states are generally over 75%
- Compliance rates associated with equipment rated efficiency levels is high; nearly 100%
- Compliance rates for installation associated code provisions, such as duct sealing and control strategies are lower
- Commercial sector energy codes have become complex and therefore challenging for building inspectors
- Opportunities exist to improve compliance rates through third-party assistance
- Improved training procedures are needed to promote higher energy code compliance
- Simulation modeling and other custom analysis approaches can be utilized to assess the energy impacts associated with overall compliance and individual provision compliance

As recommended by the DOE ARRA funding administrators, the evaluation team chose to utilize the DOE/PNNL methodology developed for commercial code compliance verification. This methodology is attractive because it provides a weighting system for the energy impacts of individual code compliance provisions. Three compliance tiers were established with tiers two and three estimated to have two and three times the energy impacts of tier one provisions, respectively. The DOE/PNNL methodology facilitates the recommended practice for code officials who are engaged in verifying code compliance during the construction process. That process involves a full review of construction documents followed by several site

visits to verify compliance. However, that process is not fully suited to the practicalities of baseline and code compliance studies. In order to make the process more usable for post-construction evaluation the team modified the methodology to reduce some of the implementation challenges while preserving its analytic advantages.

The modifications are summarized as:

- Utilizing questions that probe actual installed performance levels rather than simply "yes/no" in regards to code compliance. For example, recording actual U-Factors rather than simply ascertaining that code levels are met.
- Modifying compliance questions to allow for verification from actual field data, rather than relying on whether or not systems (lighting, mechanical, insulation, etc.) were installed "according to plans."
- Recording all observed practices directly in an iPad tool for direct upload to a custom analysis tool.
- Determining code compliance, and relative performance, for individual provisions, from recorded field data, rather than attempting to assess compliance in the field.

The above modifications, combined with extensive training of field personnel in cross-referencing obtained information to determine compliance levels of a variety of provisions, allowed the team to accurately gauge code compliance on an energy impact basis and facilitate the development of compliance enhancement programs.

With the regular introduction of more and more aggressive energy codes, and with the awareness of that standard practice in new construction tends to be somewhat lower than mandatory energy code compliance, efficiency program administrators are also becoming interested in understanding the energy impacts of different levels of compliance and building energy performance.

An ongoing phase of our code compliance evaluation effort involves definition and development of cost-effective modeling techniques to determine energy impacts. Engineering methodologies that are under consideration include simulation modeling, custom spreadsheet analysis, and a combined, integrated approach. Currently, we are conducting meetings with energy modeling experts to assess the merits of various techniques, striving to arrive at conclusions on the most suitable mix of approaches, including:

- Simulation modeling and analysis – Simulation analyses are being performed with DOE-2 based models like eQUEST. While the authors do understand the merits and analytical power of these tools, particularly for proto-typical buildings, we are also considering the challenges and costs of such analyses for real, complex facilities in which construction details may be poorly known. Thus, our intentions are to use simulation analyses to model code deficiencies associated with major envelope systems, central controls, and other whole building challenges.
- Custom spreadsheet analysis – For many stand-alone code requirements, including those for lighting, HVAC, local controls, and smaller envelope issues, custom-developed spreadsheet tools are typically most suitable. These can be more cost-effective, straightforward in use, and transparent in quality control assessment.
- Integrated approach – As indicated, there are merits to both simulation and custom spreadsheet modeling analyses. Our end objective will be to combine the two approaches, likely using the simulation for determining major building envelope, whole building control, and interactive impacts, and using spreadsheet analyses for lighting, unitary HVAC, and individual control measures.

The final results of our work will demonstrate a cost-effective and enhanced analysis protocol, providing energy impacts for a project from standard practice to compliance and then to premium efficiency. Such methodologies must be consistent with the need to assess complex new construction projects, while developing evaluation-ready energy results.

Impact of Advanced Power Strips in Office Buildings

Poster Authors: Brian McCowan (ERS), Elizabeth Titus (Regional E, M&V Forum), Chris Neme (Energy Futures Group)

Introduction

This poster presents the results of a field study completed late in 2012 on the impact of Advanced Power Strips (APS) in commercial office environments. While there is a significant body of published studies on residential applications of advanced power strips, there is little empirical information about the impacts from commercial applications of this emerging technology. The goal of the study was to: characterize typical power usage during active and inactive work periods associated with representative office workstation configurations; estimate the potential savings associated with controlling workstation peripheral equipment through the utilization of APS systems; and recommend protocols for the prediction of potential APS savings, and for conducting impact evaluation of APS programs.

The study results are based on analysis of data collected from metering and user interviews from a sample of 40 workstations in two types of office buildings. The poster summarizes the research method, results, and summary conclusions and recommendations.

Study Methodology - The primary field research for this study was conducted at two commercial office buildings in the State of Vermont. Twenty workstations in each building were monitored for power consumption patterns for a period of two weeks. The collected data was uploaded to custom spreadsheet tools and the potential savings for currently available Tier 1 APS systems were evaluated. Tier 1 APS devices are considered to be plug-in power strips containing one "control" outlet, which allows a device such as a television or a PC to act as a "master control." Multiple "controlled" outlets automatically interrupt power to controlled devices when the "control" device is off or in a low-power standby mode. Additional uncontrolled outlets allow some devices to be left regardless of the status of the control device.

The monitoring procedure followed was systematic and consistent with an effort to record the potential savings at the workstations without modifying or influencing any staff behavioral patterns or equipment settings. The procedure is outlined as follows:

- **Selection of monitoring equipment** – We utilized an energy monitoring device specifically designed to record the usage patterns and power consumption of plug loads. During the monitoring period the PC user continues to operate their PC and peripherals without any change in routine.
- **Pre-monitoring interview and tour** –A tour of the facilities and staff interviews assisted in selecting departments from which to select participant workstations.
- **Data logging installation** - The make and model numbers of the PC and peripherals were recorded, and a power meters were used to record power consumption for reference. Data loggers were installed and staff members were briefed. Data was logged for two-weeks.
- **APS Installation** – The data loggers were removed and replaced them with Tier 1 APS units.
- **Data Analysis** – The logged data was uploaded to custom analysis tool and the potential savings was calculated for each workstation, as well as the average for each site.
- **Follow-up Site Visits** – Approximately three months following the installation of the Tier 1 APS units, we returned to the two sites and interviewed the staff regarding their experiences with the APS

Conclusions - The results demonstrate that there are obtainable savings, but the savings are relatively small given the current state of APS technology, and the challenges associated with both the

interface with PC operating systems, and commercial office work environments. The overall conclusions are summarized as:

- Annual estimated savings for the monitored sites ranged from 0 – 32 kWh, and were very dependent upon PC setups and staff work habits.
- The APS strategy of disconnecting power to peripherals upon shutting down, or entering a "sleep" mode works reliably with most PC and peripheral configurations.
- Current APS products are targeted primarily at home entertainment systems. Current manufacturer instructions included with APS products focus almost exclusively on those installations.
- In order to harvest significant savings, PC operating system power settings, including power saving settings, must be understood and adjusted to assure compatibility with APS operation.
- At both sites, some staff members continue to leave their PCs operating when they are out of the office. In some cases, this is associated with remote access to the PC, but it is also associated with an outdated belief that PC operation is more reliable with 24/7 operation, and/or an incorrect assumption that an operating screensaver provides a power saving function.
- Laptop PCs with docking stations are workable configurations for APS, as undocking the laptop automatically drops the power at the control outlet to a very low level (+/- ½ watt) thereby disconnecting power to the peripherals.
- Manufacturers of peripheral equipment such as printers and monitors are continuing to reduce the power consumption during standby modes. This is a positive development for energy efficiency, yet limits the potential savings associated with APS products.
- M&V can be performed with a variety of accepted methods. However, simply verifying that units have remained in place, and reviewing the savings predictions, will not produce accurate results.
- Short-term persistence of APS units was reported to be very good with this study.

Because of the above limitations, upstream program approaches for Tier 1 APS devices are not likely to be cost-effective for commercial office environments. Direct install or approaches that engage facility and IT staff offer more potential for success. Such approaches provide the opportunity to carefully integrate APS operation with PC power saving settings, and staff work habits. Further refinement of APS products, include the introduction of advanced equipment and strategies, commonly referred to as Tier 2 APS promise to offer improved savings potential for APS plug load control.

Making the Switch from Watts to Lumens: A Comparison of Consumer Knowledge Across States & Over Time[1]

Monica J. Nevius, NMR Group, Inc.
Lisa Wilson-Wright, NMR Group, Inc.
Mike Strom, NMR Group, Inc.
Victoria Engel-Fowles, NYSERDA
Carley Murray, NYSERDA
Matt Nelson, NSTAR

Introduction

The FTC Lighting Facts label now appearing on light bulbs is meant to provide consistent information to help consumers make informed bulb purchasing decisions in a rapidly changing lighting market. Previous research suggests that consumer awareness and understanding of the information provided on the Lighting Facts label is low. Consumers who do not understand how to choose an appropriate CFL or screw-base LED bulb, and cannot put the Lighting Facts label to use as intended, may instead turn to much less efficient EISA-compliant halogen bulbs.

This poster examines selected findings around consumer awareness and understanding of key lighting information gathered via telephone surveys conducted between 2011 and 2013 across a number of states. These include Massachusetts, Connecticut, and New York State—all states with high levels of sustained residential lighting efficiency program activity—as well as comparison areas consisting of states with relatively limited residential lighting efficiency program activity Georgia, Kansas, and Nebraska represented a "low" program activity area and Arizona, Nevada, and Florida represented a "Moderate" program activity area.

Research Scope

The key factors measured in the studies include awareness of the Lighting Facts label, understanding of the relative energy use of CFL versus screw-base halogen bulbs, awareness and understanding of the term "lumens," and knowledge of the number of lumens cast by a 60 watt incandescent bulb.

Methods

The questions reported here were fielded via telephone to the audiences below as part of broader surveys about residential lighting. Specifically, the surveys were fielded to:

- A random sample of 551 residential utility customers across the service territories of Connecticut Lighting and Power (CL&P) and The United Illuminating Co. (UI) from February through March 2012. The margin of error for the full sample is +3.5% at the 90% confidence level.
- Random samples of residential utility customers in Massachusetts, including 600 consumers in Winter 2012 (conducted from December 4, 2012 to January 21, 2013), 604 consumers in

[1] The views expressed in this paper are those of the authors and do not necessarily reflect the views of the New York State Energy Research and Development Authority (NYSERDA).

Summer 2012 (conducted from June 18, 2012 to August 2, 2012), and 582 consumers in Winter 2011 (conducted from December 8, 2011 to January 19, 2012). The margin of error for the full samples of all survey efforts was +3% at the 90% confidence level.

- Random samples of consumers and households in the NYSERDA service area, including 510 consumers from September, 2011 to November, 2011, composed of 279 upstate consumers and 231 downstate consumers. The margin of error for the upstate group is +4.9% at the 90% confidence level; for the downstate group, +5.4%. A second survey was fielded to 720 households in December 2012 (340 Upstate and 380 Downstate). The margin of error for entire service area is 6.1% percent at the 90% confidence level.
- Random samples of 300 households each in a group of states with intermediate or "Moderate" residential lighting efficiency program activity (160 in Arizona, 70 in Nevada, 70 in Florida) and in a group of states with relatively limited or "Low" 'residential lighting efficiency program activity (160 in Georgia, 70 in Kansas, 70 in Nebraska). The margin of error at the 90% confidence level was 4.8% each for the Moderate and Low comparison areas. In order to facilitate comparison of results against the NYSERDA service area, these data were weighted to reflect demographic and housing characteristics of the NYSERDA service area.

Results

The findings show there has been little change in consumer awareness and understanding of the key information provided on the Lighting Facts label since 2011 in MA and NY. While the majority of respondents in each area demonstrated a good general understanding of the meaning of lumens, and the results of one study suggest that consumers may be beginning to realize that watts and lumens are not thesame thing, respondent knowledge of the number of lumens cast by a 60 watt incandescent bulb continues to be very low. Aided awareness of the Lighting Facts label was just 16% in the NYSERDA area—though this was higher than in comparison areas with less program activity. Taken together, the findings suggest that more educational activities are needed around the information on the Lighting Facts label in the areas studied.

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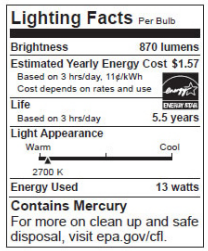
Making the Switch from Watts to Lumens

A Comparison of Consumer Knowledge Across States & Over Time

Monica Nevius, Lisa Wilson-Wright, & Mike Strom, NMR; Victoria Engel-Fowles & Carley Murray, NYSERDA[1]; Matt Nelson, NSTAR

Introduction

- The Lighting Facts label is meant to provide consistent information to help consumers make informed bulb purchasing decisions.
- Consumers who cannot put the Lighting Facts label to use as intended may be more likely to purchase less efficient EISA-compliant halogen bulbs.
- This poster examines findings around consumer awareness and understanding of key lighting information gathered through telephone surveys conducted between 2011 and 2013 across:
  - ✓ Three areas with high levels of sustained residential lighting efficiency program activity (Massachusetts, Connecticut, and the NYSERDA service area[2]);
  - ✓ Two comparison areas of states with relatively limited residential lighting efficiency program activity.



Research Scope

Key factors measured:

- Knowledge of the relative energy use of CFL versus screw-base halogen bulbs,
- Awareness of the Lighting Facts label,
- Awareness and understanding of the term "lumens," and
- Knowledge of the number of lumens cast by a 60 watt incandescent bulb.

Research Methods

The questions reported here were fielded via telephone to the audiences below as part of broader surveys about residential lighting. Specifically, the surveys were fielded to:

A random sample of residential utility customers in Connecticut

- 551 consumers across the service territories of Connecticut Lighting and Power (CL&P) and The United Illuminating Co. (UI) from February through March 2012. The margin of error for the full sample is +3.5% at the 90% confidence level.

Random samples of residential utility customers in Massachusetts

- 600 consumers in the Winter 2012 survey (conducted from December 4, 2012 to January 21, 2013), 604 consumers in the Summer 2012 study (conducted from June 18, 2012 to August 2, 2012) and 582 consumers in the Winter 2011 survey (conducted from December 8, 2011 to January 19, 2012). The margin of error for the full samples of all survey efforts was +3% at the 90% confidence level.

Random samples of consumers and households in the NYSERDA service area

- 510 consumers from September, 2011 to November, 2011, including 279 upstate consumers and 231 downstate consumers completed the survey. The margin of error for the upstate group is +4.9% at the 90% confidence level; for the downstate group, +5.4%.
- 720 households in December 2012 (340 Upstate and 380 Downstate). The margin of error for entire service area is 6.1% percent at the 90% confidence level.

Random samples of 300 households each in a group of states with intermediate or "Moderate" residential lighting efficiency program activity (160 in Arizona, 70 in Nevada, 70 in Florida) and in a group of states with relatively limited or "Low" 'residential lighting efficiency program activity (160 in Georgia, 70 in Kansas, 70 in Nebraska).

- The margin of error at the 90% confidence level was 4.8% each for the Moderate and Low comparison areas. In order to facilitate comparison of results against the NYSERDA service area, these data were weighted to reflect demographic and housing characteristics of the NYSERDA service area.

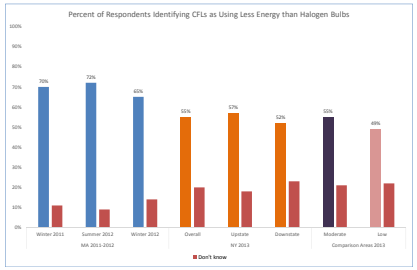
Results

Knowledge of Bulb Energy Use

Respondents were asked "Which type of bulb uses less energy to produce light?"

- While the majority of consumers correctly identify CFLs as being more efficient than screw-base halogen replacements for incandescent bulbs, consumer knowledge that CFLs are more energy efficient than halogens is stagnant, and may even be moving in the wrong direction.

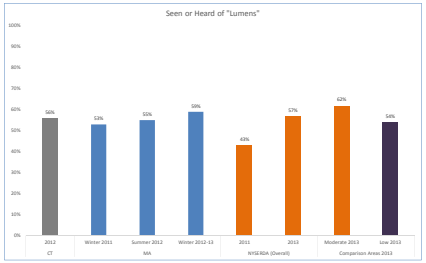
(Some of the differences in knowledge between the MA and NYSERDA studies can be explained by slightly different bases. In MA, the question was asked only of those who were "very" or "somewhat" familiar with the bulb types; in the NYSERDA study, it was asked of all who were aware of either type.)



Base: Respondents who demonstrated awareness of CFLs and screw-in halogen bulbs. Bulb types were offered in random order.

Awareness of "Lumens"

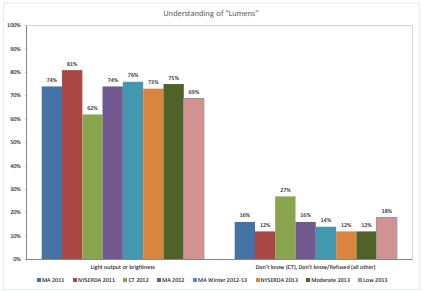
- There was growth in the percent of households that have seen or heard of the term "lumens" since 2011. The percentage of households that had seen or heard of this term in 2013 was similar across the different levels of program activity.



Base: All respondents.

Understanding of "Lumens"

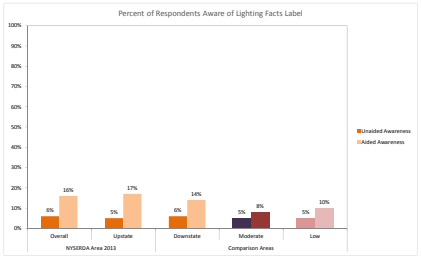
- The majority of households demonstrate a good general understanding of the meaning of lumens, with the top response offered in an open-ended question consistently being "light output" or "brightness." This has been the case since 2011 in MA and the NYSERDA service area.



Base: Respondents aware of the term "lumens"

Awareness of Lighting Facts

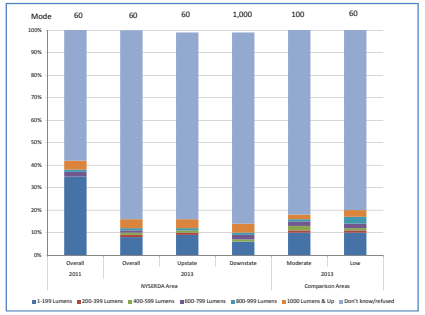
- Unaided awareness of the Lighting Facts label is very low (6% in the Overall NYSERDA area).
- Aided awareness of the Lighting Facts label was somewhat higher than unaided awareness, especially in the NYSERDA area. Awareness increased after the respondents were given a description of the label, but still remained fairly low. Respondents in the NSYERDA area (16% Overall) showed higher aided awareness than those in the Moderate (8%) and Low (10%) program activity comparison areas.



Base: All respondents.

Lumens Produced by 60w Bulb

- Knowledge of the number of lumens produced by a 60 watt incandescent bulb has remained very low (1%) for NYSERDA area consumers since 2011. Respondents who were aware of the term lumens were asked to estimate the number of lumens produced by a standard 60-Watt incandescent bulb. The majority of those who responded in all comparison areas gave lumens estimates between one and 199, and with the exception of Downstate consumers, the most frequently offered estimate was 60 lumens, indicating that most respondents are continuing to confuse lumens and watts.
- The results point to the possibility that consumers are beginning to realize that watts and lumens are not the same thing. The percentage of NYSERDA-area consumers who said that they did not know the answer increased significantly from 2011 to 2013 (from 59% to 84%), which could suggest that more consumers are beginning to realize that watts and lumens are not the same thing. However, the increase could also be due to differences in implementation by different survey research firms in 2011 and 2013.



a Statistically different at the 90% confidence level from Overall NY 2013.

Base: Respondents aware of the term "lumens."

Conclusions

- There has been little change in consumer awareness and understanding of the key information provided on the Lighting Facts label since 2011 in MA and NY.
- While the majority of respondents in each area demonstrated a good general understanding of the meaning of lumens, and the results of one study suggest that consumers may be beginning to realize that watts and lumens are not the same thing, respondent knowledge of the number of lumens in a 60 watt incandescent bulb continues to be very low.
- Aided awareness of the Lighting Facts label was just 16% in the NYSERDA area—though this was higher than in comparison areas with less program activity.
- Taken together, the findings suggest that more educational activities are needed around the information on the Lighting Facts label in the areas studied.

[1] The views expressed in this paper are those of the authors and do not necessarily reflect the views of the New York State Energy Research and Development Authority (NYSERDA).

[2] New York State excluding Nassau and Suffolk Counties.

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Assessing Interactions Between Statewide and Utility Energy Efficiency Program Offerings

Jeremy Offenstein PhD., ADM Associates Inc., Sacramento CA
Anna Espitallier, ADM Associates Inc., Sacramento CA

Introduction

Meeting statewide energy efficiency goals can be accomplished through a variety of program administrative structures. This paper addresses the program administration approach taken by states that split DSM program delivery into a set of mandated statewide programs, supplemented by additional utility-administered programs, in order to meet savings goals. We will refer to this approach as the dual-administration approach. This dual-administration approach raises several considerations for program design, administration, and evaluation. Program design under this framework presents several challenges including meeting the energy savings goals of a diverse range of utilities, accounting for the loss of economies of scale when establishing a program management framework, and maintaining customer participation in a market that involves multiple program administrators and implementation contractors. We have completed a number of program evaluations that are implemented within this regulatory structure and are expanding upon these findings to addresses the issues raised above.

Benefits of the Dual-Administration Approach

The dual-administration framework seeks to realize benefits that would not likely occur if the energy efficiency programs were operated exclusively at the local utility level, or exclusively at the statewide level. Programs administered statewide ensure equal access to a set of key energy efficiency program offerings, regardless of utility service territory boundaries. Statewide programs also allow for economies of scale in program marketing and help to develop a clear, statewide branding of efficiency. Customers are often more aware of these statewide programs than of the programs offered by the local utility. In some cases, customers who are aware of the statewide programs seek incentives for projects that may be more aligned with a utility-administered program. Thus, the consolidated marketing efforts not only increase awareness of the statewide program offerings, but may also indirectly promote the programs offered by local utilities.

Utilities can supplement state-administered programs with programs that are more tailored to the energy efficiency potential in their service territories in order to meet energy savings goals.

Challenges of the Dual-Administration Approach

Although there are benefits to offering statewide and utility efficiency programs, there are also a number of challenges that are created by this administration approach.

The use of different implementation contractors for statewide and utility implemented programs tends to create complications for customers and affiliated trade allies. Dual administered programs make it difficult to provide potential customers with a single point of contact when inquiring about energy efficiency options and offerings. A finding from our evaluation efforts is that statewide program staff spent time referring customers to utility program staff or vice versa. Although these customers are referred to the appropriate program, the added effort required of the customer may result in a loss of interest. Different implementation contractors may also make programs that work well together less effective. For example, a utility audit program may recommend the implementation of measures that are incentivized through

statewide programs. This raises the question, would a utility's implementation contractor be less inclined to recommend measures incented by state-run programs?

Another concern, as noted by trade allies, is the difficulty in keeping track of which incentive programs are applicable to different measures. From the trade ally perspective, two measures may seem similar but one qualifies for the statewide program while the other qualifies for the utility sponsored program.

Although the administration framework produces efficiencies by allowing the consolidation of marketing and administrative efforts, it also can increase administrative requirements for utilities managing sets of statewide and utility sponsored programs. Utility staff must manage multiple implementers and evaluators and must adhere to multiple sets of reporting requirements.

Optimal program design can be complicated in the dual-administration framework, which requires the development of utility programs to target potential savings that are outside of the scope of statewide programs. Targeting the remaining potential savings in a service territory can be challenging because it is difficult to offer a comprehensive program while avoiding measure overlap, i.e., supplementing a state-administered prescriptive lighting program with a utility-administered custom lighting program.

The dual-administered approach also creates evaluation challenges. Some programs are designed to complement one another, and a lack of established relationships with implementers from each administration can hinder the evaluation effort. For example, an audit program may provide recommendations for equipment incentivized under another program. The evaluation of the audit program would benefit from understanding how many customers proceeded to participate in other efficiency programs due to referrals received through the audit program. However, if under the dual administration structure there are different evaluators for the incentive programs and the audit program, this question may go unanswered.

The attribution of savings is also complicated by the dual administration structure. An example of an attribution question that arises from this dual administration structure is: to which program should savings from an incentive project that was identified by an audit be attributed when one program is a statewide program and the other is a utility program? When both programs are administered by the implementer and there is one set of savings goals to meet, this may be less of an issue than when multiple implementers are involved and utilities have goals for both statewide and utility administered programs. A second question is: when a customer initiates contact with program staff for a statewide program, but the proposed project is a better fit for a utility based program, are the savings more attributable to the statewide program or the utility program?

Key Questions

1. How can efficiency programs operating under a dual administration framework be organized to make participating simple and straightforward for customers and contractors?
2. What program design process will result in utility programs that best compliment statewide program offerings while minimizing their operation costs relative to realized savings?
3. What type of policy framework be developed for the attribution of savings in an environment where statewide and regional investments in energy efficiency are made?

Realizing Evaluations Produce Estimates NOT "Certainty"

John P. Proctor, P.E., Proctor Engineering Group, Ltd.

Introduction

This poster presents research into the problem of overstating the results of evaluations simply in the words used to describe the results. How often have you seen the words: "True", "Actual", "Measured", "Real", etc. ascribed to the results of an evaluation? This poster presents the statistics from just one conference.

Rejoinder: "But everyone knows that these are really estimates." If "everyone" knew that these were estimates, not absolute facts, it would still be incumbent on the evaluator to use accurate wording that was less likely to be misinterpreted by the reader of the evaluation. The most common readers of evaluations are not high level statisticians, but rather utility personnel, utility regulators, and others that can, and do, easily take the results of evaluations as absolute and immutable facts.

These estimates, taken as facts, become embedded in policy and calculations such as the California Database for Energy Efficient Resources (DEER). Many readers do not recognize that, generally, evaluations are of programs, not of measures. The results of a particular program are erroneously taken as establishing the value of a measure, without regard to how or to whom the measure(s) in the program were applied.

The Statistics

In 192 documents from the 2011 IEPEC, we find:

- Measured- 67 documents, 141 instances
- Real- 50 documents, 110 instances
- Actual- 73 documents, 210 instances
- True- 37 documents, 75 instances

The Problem

The problem doesn't necessarily originate from the EM&V professionals, but sometimes when non-technical people take evaluation reports and ignore the word "estimate". This may be because they think in black in white instead of shades of gray, or because they are trying to make the most compelling case possible to support some agenda and facts sound more compelling than estimates.

As professional evaluators we need to watch both our use of statistics and our use of words that provide an easy path to misinterpretation.

The Poster

The poster includes some examples of how the words we use sometimes assist misinterpretation.

TMY3 is Not Normal, Nor is it Typical – The New Normal is a Trend!

John P. Proctor, P.E., Proctor Engineering Group, Ltd.

Summary

This poster emphasizes the proper and improper use of the Typical Meteorological Year 3 (TMY3) and published Cooling Degree Days (CDD).

This process analyzed 167 National Solar Radiation Data Base Class I stations' daily data for the 62 years from 1960 through 2012. It found a generally increasing trend in ambient temperatures that resulted in increasing CDD year over year. This finding is significant because it is not uncommon for evaluations to use published CDD or CDD's derived from TMY3 to "Normalize" the results of evaluations. These methods are also used to project usage and savings results into the future.

For most locations, any method that uses an average of cooling degree days over some time period will necessarily result in an erroneous conclusion. It is simply true that, for most locations, there is a rising number of CDD (and a falling number of Heating Degree Days). For these reasons evaluations should take into account this "new normal" in normalizing the results and for projections into the near future.

Utilizing simple linear regressions: $CDD_i = C_i + a_i \times year$, two thirds of the stations showed at least a .05 predictive value attributed to the year. One example of the trend in CDD is shown in Figure 1. This figure also shows the inaccuracy associated with a CDD that is based on an average over a number of years.

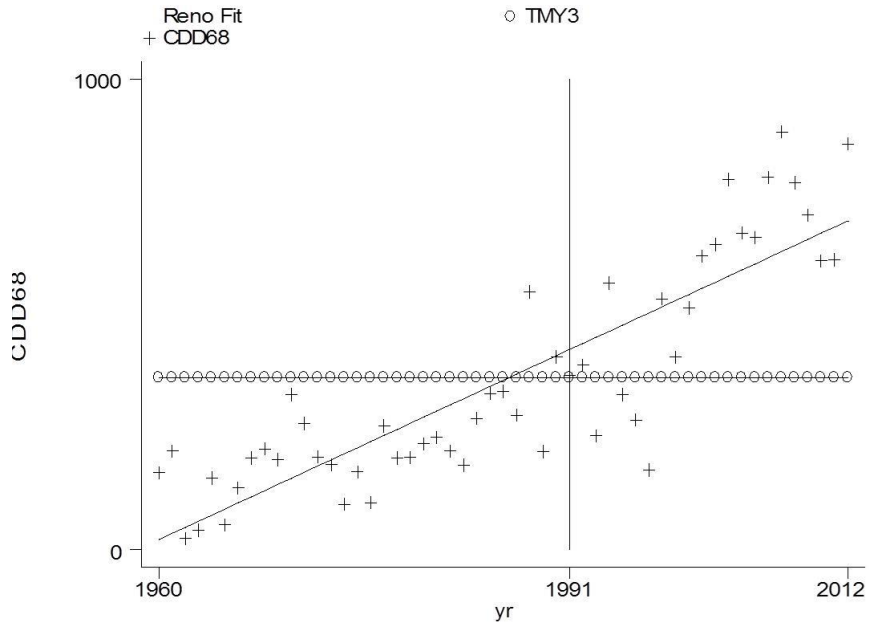

Figure 1. Actual and TMY3 Generated CDD (base 68ºF) vs. year for Reno, Nevada

Both the R2 and the t values of the coefficient "a" show statistical significance of the trend. Figure 2 shows the t values for the coefficient of the year within the regressions.

The values of a (the change in CDD68 per year) range from -0.16 (t value -0.16) for Cedar City, Utah to +26.97 (t value 10.7). Figure 3 shows the values of the coefficient a.

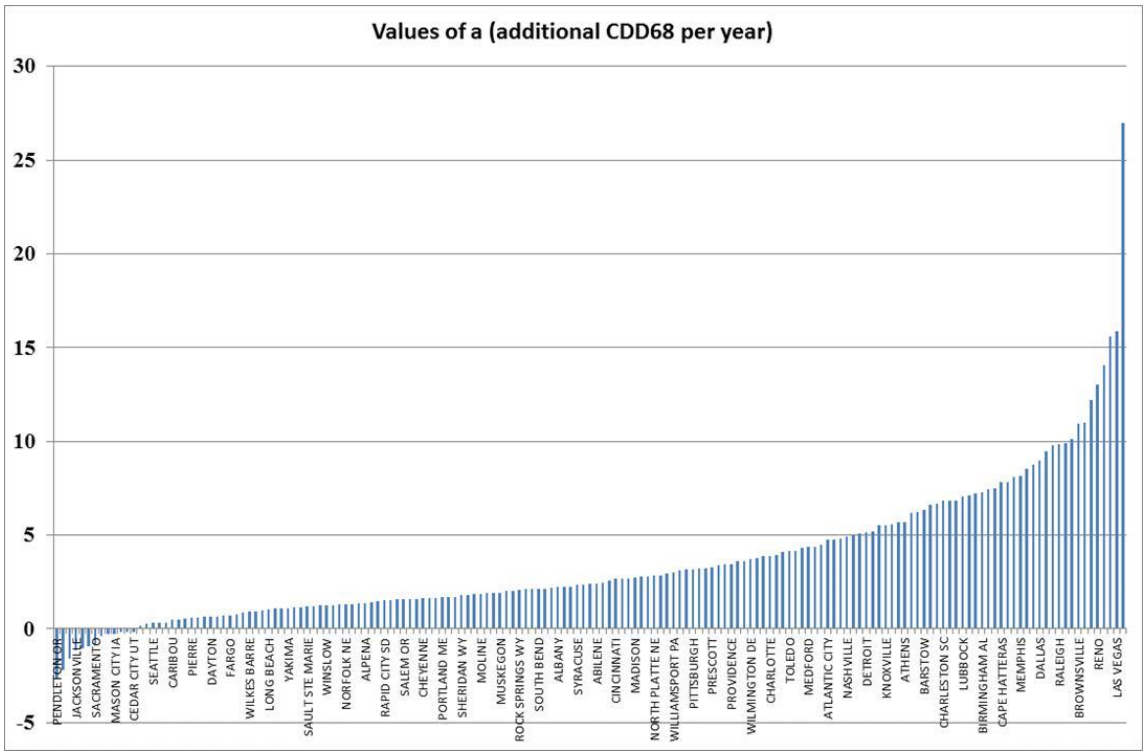

Figure 2. t Statistics for the coefficient of year in the regressions

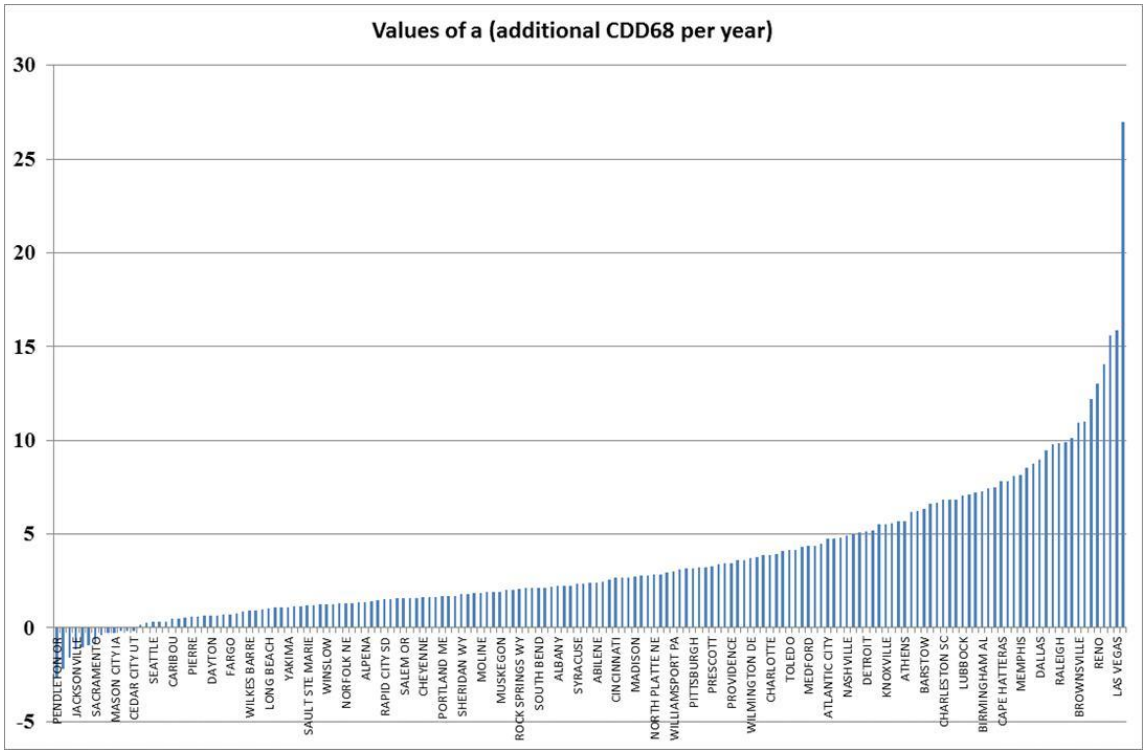

Figure 3. Values for the coefficient of year in the regressions

Farewell T12s, Parting is Such Sweet Sorrow

Bob Ramirez and Jean Shelton, Itron Inc, Consulting & Analysis

Introduction

Commercial lighting constitutes approximately 30% of commercial electricity usage, and as a result, lighting energy efficiency programs are usually the largest source of commercial sector savings for most utilities. According to a recent DOE report, linear fluorescents are the predominant commercial area lighting technology, and T12s are 33% of the 2010 linear fluorescent stock. So although the conversion/replacement of T12s to T8-T5s has been encouraged for many years by utility programs, this seems to show that, to paraphrase Mark Twain, the reports of the death of T12s have been greatly exaggerated. However, the latest lighting standard legislation ensures that the imminent demise of T12s is only a matter of time.

Farewell T12s (and 700-series T8s!)……..

The Energy Policy Act of 2005 (EPAct) was a sweeping piece of legislation, enacting the most significant update to the nation's energy policy since the 1990s. The most recent impact of this legislation occurred in July 2012, when federal lighting standards, via new lamp efficacy (lumens per watt) requirements, prohibited the manufacture of almost all 8-foot and 4-foot T12s. This legislation also affects first-generation, 700-series T8 lamps, which also do not meet the new lamp efficacy standards. However, a two-year extension was granted to allow these lamps to be manufactured until July 2014. Another significant issue to consider is that the Standards only prevent the *manufacture* of these lamps, so they can and will continue to be sold, as long as there is available inventory.

…..Parting is Such Sweet Sorrow

The implementation of these new lighting standards will have significant impact on energy efficiency programs, as well as implementation, evaluation, and savings potential and goals, especially retrofit lighting measure baseline assumptions and Net-to-Gross values. As the result of these actions, energy savings will be lower using a T8 baseline instead of a T12 baseline. T8 lamps will now also need to be characterized by series (700, 800 or greater) and other performance values, which can only be obtained from the lamp model number. It also means that 800-series T8 lamps will become the new baseline for linear fluorescent energy efficiency measures. There is also the issue of timing to consider, that is, should the baseline be shifted immediately to an 800-series T8 or should it be phased in slowly over a number of years (some jurisdictions have already decided on an approach). And finally, the T8 system ballast information will also be needed to characterize the system as a high-performance T8 (HPT8) system. This all requires a different, more extensive effort to characterize linear fluorescent lighting.

The Need: CPUC Baseline, Evaluation, and Measure Cost Studies

Itron is conducting three studies for the California Public Utilities Commission (CPUC) that require linear fluorescent characterization. The first is the Commercial Saturation Survey-Commercial Market Share Tracking (CSS-CMST). The CSS effort is a baseline equipment saturation survey, while the CMST effort is focused on new, recent (Jan 2009) equipment purchases including linear fluorescent lighting. The second is

the Nonresidential Lighting Evaluation study, which will use the data from the CSS-CMST study for determining baselines. The third study is the Measure Cost Study, which will attempt to determine the incremental costs of linear fluorescent lamps, ballasts, and fixtures. The first two studies include on-site surveys, and are the source of the lamp and ballast make/model data being used for this effort. These projects are all still in progress, and final results and data are not expected to be available until the first quarter of 2014.

Linear Fluorescent Performance Categories

These lookup tables will be used to determine linear fluorescent "performance categories" (non-EPAct compliant, base/standard efficiency, and high efficiency), and express saturations for each category. The accurate development of the lighting performance categories, and the current shares of technologies, hinges on the collection of make and model number information and the implementation of the efficiency lookup tables. The linear fluorescent lighting performance categories that will be used for these studies, listed from least efficient to most efficient are: *T12, 700-series T8s, 800-series T8s, CEE high-performance standard-watt and reduced-watt T8s, T5s, and LED T-8 replacements.* These performance categories will be used for consistency throughout the CPUC studies that are using this data. When the revised Standards are fully in force, eventually both theT12s and 700-series T8s will need to be phased out as a baseline, and the 800-series T8s will be the new baseline.

Lamp-Ballast Model Lookup System

Extensive make/model number reference tables are being created for both lamps and ballasts. The tables include data collected from both past and current on-site surveys. This data will be used to characterize lamp and ballast performance, as well as to determine fixture wattages which will be used for equipment saturation analysis and evaluation.

Lamp Model Lookups. An example lamp model number is F32T8/841/XP where the 841 represents the series. Both make and model along with lamp diameter, watts, and length are mapped to these lamp performance characteristics: CRI, Rated Lamp Life, Rated Lumens, and Consortium of Energy Efficiency (CEE) certification. Almost all energy efficiency programs require CEE HPT8 systems (lamps and ballasts). These characteristics are important because they are used to check against the Standards which define efficacy in terms of lighting performance parameters, not just by lamp type or technology (i.e. T12).

Ballast Model Lookups. An example ballast number is B232IUNVEL-A, where the "232" means two 32W T8 lamps. Ballast parameters are Type (electronic, magnetic), Start Type, Ballast Factor , Fixture Input Watts, and CEE-certified.

Fixture Input Wattage Lookups. The lamp and ballast model lookup tables will be combined with on-site survey data to determine actual fixture wattages, which will be used to calculate evaluation ex post.

Data Applications

The linear fluorescent performance group saturation results of this study will be used as inputs in models to determine energy efficiency potential, for defining standard practice from a fixture configuration basis rather than a lighting power density basis, and by program planners to help design updates to existing lighting programs. The efficiency lookup tables will be available to utilities and the commission to true up or enhance Standard Fixture Wattage lists (which are typically used for lighting programs) and for future evaluations.

Why Won't You Answer My Questions?

Mandy Pom, Tetra Tech, Madison, WI
Pam Rathbun, Tetra Tech, Madison, WI

Introduction

Energy efficiency program evaluations can require a considerable amount of data collection. Evaluators need to speak with program participants and nonparticipants to assess a variety of issues, including verification of installation, program impacts, process experiences, awareness, and participation barriers. Collecting high quality data and maximizing response rates (to minimize potential for nonresponse bias) can be expensive. This is particularly true for nonparticipant and general population studies where customers do not have a connection to the survey topic through program participation. Decreasing use of land-lines and higher incidence of call-screening exacerbate the difficulties of achieving representative samples. We have been experimenting with different survey methods to identify procedures that will increase response rate and help control data collection costs.

Study Experiments

Midwest Utility Residential Nonparticipant Study: Incentive Amount and Notification Type Experiment. Households were randomly assigned to receive no incentive, a $5 prepaid incentive, or a $10 prepaid incentive. Households receiving no incentive were also randomly assigned to receive an advance postcard or an advance letter. When no incentive was offered, an advance letter was slightly more effective than a postcard. Response increased with the $5 incentive and increased further with the $10 incentive.

Midwest Utility Residential HVAC and Water Heating Participant Study: Incentive Type Experiment. To encourage participation in a telephone survey, a Midwest utility offered a $20 incentive using different types of gift cards. Each sampled participant was randomly assigned to receive, upon completion of the telephone survey, a $20 gift card from their utility, a gift card for Meijers, or for Walgreens. Neither the $20 incentive itself nor the type of gift card had a large impact on the survey response; in fact, the telephone survey response rate was somewhat lower this year over last year, when an incentive was not offered.

Midwest Utility Residential Direct Load Control Study: Mode Experiment. The client requested a 100 percent response rate on a seven question general population study. A $10 cash prepaid incentive was included with a mail survey, and households could participate by telephone or on-line if they preferred. When offered an advance incentive along with options for completing the survey, an 86 percent response rate was achieved. More than 75 percent of completed surveys were from the mail survey.

Midwest Utility Education Study: Teacher Incentive Experiment**:** Contact information for students' parents is seldom available due to confidentiality, but parent surveys can be requested in materials sent home with students from school. To increase parent survey participation, teachers were offered an incentive if 25 percent of their students' parents completed the survey. Offering this incentive doubled parent survey completion over the prior year.

Midwest Recreation Study: Incentive Placement Experiment: A prepaid $5 cash incentive was included in a mail survey and placed in various locations on the cover letter and survey booklet. Results indicated that the placement of the five dollar bill, whether visible or not visible before removing contents from the envelope, did not have a large impact on the survey response rate.

The Next Generation of Consumer Electronics Programs

Nicole D. Rosenberg, NMR Group, Inc.
Monica Nevius, NMR Group, Inc.
Ralph Prahl, Energy Efficiency Advisory Council of Massachusetts
Glenn Reed, Energy Efficiency Advisory Council of Massachusetts
Matt Nelson, NSTAR
Wendy Todd, National Grid

Introduction

This poster summarizes findings from a qualitative study of the potential for consumer electronics energy-efficiency programs in Massachusetts in 2012. It describes the current barriers to and opportunities for greater energy efficiency for each of the key consumer electronics product areas, touches on saturation of consumer electronics products in the state, and describes findings and offers related program recommendations. While the results are focused on a particular state, the findings are relevant to other jurisdictions across the U.S. and Canada.

Background

As of 2010, consumer electronics was estimated to comprise 13% of residential electricity consumption (Urban et al. 2011), making it a product category worthy of program attention. Yet consumer electronics is a particularly challenging area for energy efficiency programs. For example, the consumer electronics market moves at a far faster pace than most other product areas and especially than the utility regulatory environment. As a result, programs risk lagging behind the market and incentivizing free riders or obsolete products. The global nature of the market is also a challenge for program attribution. Variations in consumption associated with user behavior and the numerous possible combinations of peripheral devices that could increase the consumption associated with products of interest make identifying deemed savings and reductions from consumer electronics difficult.

Drawing on both secondary and primary research, the study focused on a series of product categories that together represent more than three-quarters of consumer electronics energy consumption: TVs, set-top boxes, computers and displays, and video game consoles (Urban et al. 2011). It also included an assessment of savings opportunities from "smart" power strips (also known as advanced power strips [APSs]).

Methods

Research methods include a review of current literature, in-depth interviews, and a study of product saturation in Massachusetts. The research team chose literature for review based on relevance to the topic, timeliness, and the research team's perceptions of quality and reliability. The team conducted in-depth interviews with 21 organizations and 26 individuals representing five different types of organizations: program administrators running leading consumer electronics programs, stakeholders and policymakers involved in setting specifications or regulations, retailers, manufacturers, and media service providers and industry representatives. The team also conducted an onsite saturation study of residential retail products in the state, collecting data to identify the rate at which different consumer electronics were found in 150 households in the state. All data collection and analysis was completed in 2012.

Results

While the study was conducted on behalf of Massachusetts program administrators, the findings and observations are broadly relevant across the U.S. and Canada. The following are some of the research team's key observations from literature and in-depth interviews:

- The consumer electronics market changes quickly, facilitating rapid saturation and free ridership. Updating program criteria frequently and relying on more rigorous specifications will diminish free ridership.
- Collaboration between program administrators and a broad range of other programs and stakeholders will increase the likelihood of program engagement with larger retailers and manufacturers. Program administrator interviewees noted that identifying a single point of contact for consumer electronics programs across a region makes program participation less burdensome for industry.
- Successful consumer electronics programs are designed with an understanding of the typical design, production, and sales cycle of each product.
- Product-specific challenges exist. For example, TV efficiency likely will not dramatically increase in coming years, and desktop PCs and displays markets are shrinking and as a result are not relevant program foci.
- Increasing the efficiency of set-top box devices alone will not sufficiently address their energy consumption. Incorporating their functions into thin-client boxes or TVs to decrease the number of devices per home can reduce their energy consumption.

The findings raise some fundamental questions about the place of consumer electronics in energy-efficiency programs. The research team suggests four basic approaches to consumer electronics for program administrators to consider. While program administrators could potentially abandon program support for consumer electronics in the face of the challenges of addressing them, the research team does not recommend this option. The research team concludes that programs could consider limiting their support for consumer electronics to focus on encouraging the development of more rigorous energy efficiency specifications and standards. Programs may also want to take long-term market transformation approaches to reduce overall miscellaneous plug loads as a broad category instead of through product-by-product incentive approaches. The fourth option is for programs to continue to offering product-focused programs, but with modifications integrating the findings from this study to improve effectiveness.

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The Next Generation of Consumer Electronics Programs

Findings from a Qualitative Potential Study for Massachusetts Program Administrators

Nicole D. Rosenberg, NMR Group, Inc.; Monica Nevius, NMR Group, Inc.; Ralph Prahl, Energy Efficiency Advisory Council of Massachusetts; Glenn Reed, Energy Efficiency Advisory Council of Massachusetts; Matt Nelson, NSTAR; and Wendy Todd, National Grid

Research Objective

NMR conducted this consumer electronics qualitative potential study in 2012 for the Massachusetts energy efficiency program administrators. Currently, the Massachusetts' ENERGY STAR Appliances and Products Program administers an initiative addressing consumer electronics. The primary goal of the qualitative potential study was to identify factors affecting consumer electronics energy efficiency that the Program could address directly through program activities.

Research Scope

The study focused on identifying and understanding program opportunities for, and barriers to, technologies and interventions that represent the greatest sources of potential savings from consumer electronics. In 2010, together the following represent over three-quarters of the total U.S. energy consumption of consumer electronics: Televisions (TVs), Set-top boxes (STBs), Video game consoles, Personal computers (PCs), and Displays.[1] 'Smart" or advanced power strips (APSs) were also addressed in this study as energy saving devices for consumer electronics.

Research Methods

For the potential study the research team collected data via two methods: a review of current literature and in-depth interviews. The literature review for this study was conducted between April and May, 2012. In-depth interviews were conducted between June and August 2012. Given the fast-changing nature of the consumer electronics market, some of the information presented here may have changed in recent months.

Literature sources were chosen based on their relevance to the topic, recentness, and the team's perceptions of their quality and reliability.

The team conducted in-depth interviews with 21 organizations and 26 individuals representing five different types of organizations:

- Program administrators outside Massachusetts running leading consumer electronics programs, and staff of the implementation contractor responsible for running the Massachusetts Program. The research team identified "leading" consumer electronics programs based on the literature review and input from other interviewees.
- Stakeholders and policymakers involved in setting specifications or regulations related to the energy efficiency of consumer electronics, including advocacy organizations working on consumer electronics energy efficiency.
- Retailers of consumer electronics. Since Massachusetts Program efforts have targeted larger retailers, the research team interviewed representatives from large chain retailers.
- Manufacturers of consumer electronics.
- Media Service Providers and Media Industry Representatives. Media service providers control media transport through cable, satellite, or Internet networks

Key Observations from Literature and In-depth Interviews

Consumer Electronics Overall

- **Consumer electronics specifications would save energy more effectively if they were more rigorous.** There is little reason to expect manufacturers to make, or retailers to promote, energy efficient products without programs and without voluntary specifications such as ENERGY STAR to encourage these activities. Program administrator input could drive more rigorous specifications.
- **A product-by-product approach may not be sufficient to reach ambitious program savings goals.** A long-term market transformation approach to reduce overall miscellaneous plug loads as a broad category may be more effective than a product-by-product incentive approach.
- **Midstream incentives appear to be more effective than downstream incentives.** The vast majority of programs do not offer downstream incentives for consumer electronics. A retailer interviewee observed that high processing costs from downstream incentives are not generally effective for consumer electronics products.
- **Removing inefficient electronics from the grid could be a promising program approach, particularly for TVs.** Adding efficient TV models does not remove less efficient models from the grid. For example, after purchasing an energy-efficient TV, customers will often turn their older TV into a secondary TV instead of removing it from the grid entirely.
- **Successful consumer electronics programs are designed with an understanding of the typical design, production, and sales cycle of each product.** One program administrator representative indicated that understanding the buying cycles of consumer electronics retailers is especially important given the rapidly changing consumer electronics market.
- **Collaboration between program administrators and a broad range of other programs and stakeholders will increase the likelihood of program engagement with larger retailers and manufacturers.** Program administrator interviewees noted that identifying a single point of contact for consumer electronics programs across a region makes program participation less burdensome for industry.
- **Third parties can successfully facilitate data collection from retailers to help inform program design plans.** The third party facilitation will not risk retailer privacy because the third party is not under the same regulatory requirements to make its documentation public as are program administrators.
- **Programs must provide retailers with training around program offerings.** Retailers need substantial assistance in adapting to efficiency program needs.
- **Online or mobile tools can help guide consumers to program-eligible products and to retailers selling such products.** One program administrator interviewee suggested that Internet-based applications could help consumers identify energy-efficient, program-eligible models of consumer electronics.
- **The consumer electronics market changes quickly, facilitating rapid saturation and free ridership.** Updating program criteria frequently and relying on more rigorous specifications will diminish free ridership.

Televisions

- TV efficiency likely will not dramatically increase in coming years.
- Market actors do not value energy efficiency highly in their TV usage, purchasing patterns, promotion techniques, and design approaches.
- Market trends point to the possibility of TV free ridership.

Video Game Consoles

- There are not ENERGY STAR specification for game consoles.
- One stakeholder interviewee reported that the Natural Resources Defense Council is negotiating with manufacturers to promote advancing game console flexibility to increase efficiency.
- Potential European regulation changes could increase game console efficiency. The research did not yield a clear path for the Program to address game consoles. Until one emerges, the Massachusetts program administrators may wish to keep an eye on progress toward European efficiency standards, and to examine and consider

Set-top Boxes

- Increasing the efficiency of the device alone will not sufficiently address STB energy consumption. Incorporating STB functions into thin-client boxes or TVs to decrease the number of STBs per home can reduce STB energy consumption.
- Partnering with media service providers to reduce STB energy consumption has led to program success. However, the Massachusetts program administrators have tried this approach in a previous program with little success.

Desktop and Mobile PCs

- Desktop PCs are a shrinking market and as a result are not a relevant program focus.
- Cost is a major market barrier to advancing energy efficiency for desktop PCs.
- Desktop and mobile PC programs have been unsuccessful.
- ENERGY STAR has penetrated the mobile PC market.
- Cloud computing continues to grow, shifting power requirements to data centers. As a result cloud computing will reduce home desktop and mobile PC energy consumption.

Displays

- Consumer behavior may inhibit savings from displays.
- Displays may be an irrelevant product category given that the market appears to be shrinking.

Advanced Power Strips

- Savings from APSs will diminish as other devices become more efficient.
- The savings associated with APSs are difficult to quantify.
- APSs are not appropriate for use with mobile PCs.
- Consumers lack awareness around APSs and how to use them.
- Direct install approaches have effectively increased the installation and usage of

Recommendations

Observations from the literature and in-depth interviews suggested four basic options to consider as alternatives to Massachusetts Program Administrators' approach to consumer electronics as of 2012:

- Abandoning program support for consumer electronics
- Limiting support for consumer electronics to encouraging the development of more rigorous energy-efficiency specifications and standards
- Changing the focus for the consumer electronics portion of the Massachusetts program from individual products to overall reduction of miscellaneous plug load energy use intensity through market transformation efforts, including but not limited to consumer education and behavior change
- Maintaining the current product-focused program, but with modifications to improve effectiveness

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Get Out The Watt! Drawing Parallels with a GOTV Campaign and Influencing Behavior for Results in Energy Efficiency

Gomathi, Sadhasivan, DNV KEMA

Introduction

The intersection of big data, social data, primary research, and analytics has proven to be a sweet spot for several industries/verticals, including the recently concluded presidential election campaign which was a great example of a program that leveraged information and deployed advanced analytics to get desired results. Are utilities mining the information they have at their fingertips to understand their customers better and use this understanding to design programs that enable more effective engagement? This poster presents a first-hand account from the perspective of a target audience and a volunteer for the campaign, is augmented by supplementary research, and is informed by the author's experience with advanced analytics.

Database Integration

Database integration is a foundational step combining party affiliation, geographic information, past financial support, volunteering efforts, requirements for assistance etc. into one large database accessible to different arms of the campaign. While some of this is available to the party from its own records, it may be augmented with purchased data as well such as social media usage, cell phone usage, lifestyle segments etc. Drawing a parallel, this database integration would be equivalent to utilities maintaining one master customer database that collated billing, payment, account services, and marketing databases to have at their fingertips a holistic profile of a customer on aspects such as energy consumption, whether customers have been delinquent on payments, preference to receive electronic bills, typical mode of bill payment (check, draft, online debit, online credit etc.), customers who might have availed of rebates on past programs, signed up for TOU rates or levelized billing plans, low income customers requiring bill payment assistance, aged/disable customers who indicate that disruption in service might be detrimental to their well-being etc. This is just a sampling of the information that utilities have on their customers. This can be further augmented with purchased information regarding cell phone usage, presence of solar, EV ownership and many other such variables that are relevant to customer behavior, attitudes and needs with respect to energy consumption.

Program elements may be tailored and localized to increase relevance using geocoding and mapping. Akin to directing volunteers to the nearest phone center and voters to the right location to vote, energy efficiency programs can adopt a parallel approach that provides specific local information to customers that spurs action. For example: providing resources that direct consumers to retail channels that carry rebated energy efficiency appliances within a X-mile radius. Utilities possess tracking data for EE measures that can be used for this purpose.

Methods

Cluster analytic techniques are used to identify distinct segments of voters that exhibit similar patterns in the above variables. Developing segments allows programs to tailor messaging to groups rather than employ a one-size fits all approach. Predictive models are used to identify high probability targets for all desired outcomes from simply casting a vote in favor, to fundraising, to volunteering etc. Similar

approaches may be employed to develop customer segments and also develop propensity scores for customers to participate in a program, reduce consumption, load shift etc. Segment profiles also provide seed information for marketing and messaging optimization. For example: Receipt of electronic bills and scheduled automatic online bill payments might be a proxy indicator of receptivity to smart energy offers such as TOU rates. Customers exhibiting this pattern of data might cluster together in a segment and be likelier to adopt SEOs than those lacking a threshold level of technology use.

Segment profiles are useful to allocate marketing spend by channel and allow tailoring of messaging by a priori needs known for these segments. For example, the campaign ascertained higher probability donors and prioritized outreach accordingly or those who required assistance in getting to the polling place and reassured voters that they would receive the support they needed. Similarly, utilities can use customer profiles and indicators such as billing payment assistance or disruption detrimental indicators to explain the benefits of SEOs such as TOU rates in terms that appeal to those particular segments such as more competitive rates that could reduce the size of the bill for the low income groups or increased reliability via shorter outages and remote assistance for the elderly/disabled.

Implications

Normative behaviors are leveraged and social networks are used to amplify performance. Increased voter turnout can be attributed to the network effect just as comparative home energy reports have used peer group comparisons to generate anywhere from 1%-3% energy savings. Customer information is updated dynamically with each contact, inbound or outbound, and the process may be described as one of continuous enrichment and refinement. Notwithstanding privacy issues, as our ballots are subject to privacy regulations just as our energy consumption information is, an effective GOTV/GOTW campaign can employ a data driven strategy to achieve its goals.

Maximizing Return on Research Investment: The Role of Repeatable Sample Frame Development Processes

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Introduction

Maximizing return on research investments is a key tenet in ensuring the prudent use of ratepayer funds. Nevertheless, research studies and program evaluations are continually conducted in a manner where primary data collection efforts, including sampling design and sample frame development, are repeated study-by-study—even when examining the same population. This is costly and inefficient, especially when dealing with large, ill-defined populations. Further, some populations are difficult to define and the development of a complete, accurate, and up-to-date sample frame is a complex undertaking due, among other things, to the availability, quality, and completeness of the population data. This makes comparability across studies questionable.

Repeatable sample frame development processes are essential to upholding the maximization of return on research investment. These types of studies, where steps undertaken are clearly delineated and unit of analyses are clearly defined, enable: (1) true comparability among existing and future research studies, (2) the potential for more valid and reliable leveraging of past efforts to streamline future research, and (3) the refinement of research design and accurate, lower-cost budgeting. This poster presents our efforts to develop a reliable and valid sample frame for a population of significant interest to the energy efficiency field—HVAC contractors and technicians in California.

Approach

There has been and continues to be substantial interest in better understanding the California HVAC industry as it remains one of the most promising industries in which significant gains can be made in terms of energy efficiency. However, this industry has always been difficult to study because it is large, ill defined, and constantly in flux. In 2012, Energy Market Innovations (EMI) was tasked by the California utilities to conduct the California HVAC Contractor and Technician Behavior Study. This study was aimed at gaining a better understanding of field behaviors and practices of HVAC contractors and technicians. In conjunction with this behavior research, EMI was also tasked with developing "a sampling frame and a repeatable sampling frame definition process that best defines and characterizes the true population of California HVAC contractors" to determine valid and reliable estimates of several key rates that, to-date, have been quite elusive. These include:

- The incidence of contractors who are actively working in the HVAC industry
- The incidence of contractors who offer installation, maintenance, and/or service to their customers

- The incidence of contractors working in the residential, small commercial, and large commercial markets

Methods

This research was conducted as a two-phase study, where the above rates were determined from brief telephone surveys (the Incidence Study), where we also collected email addresses in order to conduct follow-up web surveys to explore the behaviors and practices (the Behavior Study—not discussed here).

The sample frame for the telephone surveys was developed from the list of contractors contained in the California Contractors State License Board (CSLB) active C-20 (Warm-Air Heating, Ventilating and Air-Conditioning Contractor) licensee list, obtained on December 17, 2011 from the CSLB. The C-20 database was considered the appropriate starting point for developing the sample frame because HVAC contractors are required to be licensed to conduct business in California. The greatest challenge of using this list was that individuals hold licenses, not firms, and many firms had multiple licenses associated with it. Since the contractor firm was the unit of analysis for this study, significant effort went into processing the file to ensure the "contractors" only showed up once in the final sample frame. The original file of 10,806 C-20 licenses was de-duped by company address and phone number and the resulting file of 10,486 cases defined the sample frame of California HVAC contractors for the telephone survey. EMI completed 496 total surveys to determine incidence rates.

Findings

In this poster we address: (1) the specific steps undertaken to develop the sampling frame, which defines the repeatable sampling frame definition process and a subsequent incidence study that best defines and characterizes the true population of California HVAC contractors, (2) the challenges encountered in this process, (3) the lessons learned through this process, and (4) the benefits of the research for not only understanding HVAC contractor and technician maintenance and installation behavior, but how this work maximizes the return on research investment for future HVAC contractor and technician studies in California. Some key findings are:

- Up-to-date population data is a key along with a clear understanding of the content of the data, and an understanding of what the limitations are with regards to what the data contains—and what it does not contain!
- A clear definition and understanding of the unit of analysis governs all sample frame development steps, and also affects how useful the sample frame is for future work.
- Automating sample processing steps with text recognition algorithms would be time-saving and offer the potential to reduce data processing errors
- Overall, a well-designed and processed sample frame—or a repeatable process for developing the sample frame—can be used for multiple studies, which offers numerous benefits, not limited to the following:
    - Generalizability and comparability of results across multiple research efforts
    - Significant cost efficiencies in conducting the research
    - Significant time efficiencies associated with reducing the number of tasks necessary to conduct research studies.

Market Transformation in Commercial Food Service: Integrating DSM into Procurement Processes

Adam D. Thomas, ADM Associates, Inc.

Introduction

This poster expands upon the findings of a process evaluation conducted by ADM Associates for a mid-southern natural gas utility's commercial food service rebate program. The program provided financial incentives for both the installation of high efficiency options within traditional equipment classes as well as for the adoption of alternative cooking technologies (where a program participant would install equipment that utilizes a differing cooking process). This poster examines the approaches and points of intervention for a range of commercial food service end-users, including corporate chain restaurants, independently-owned restaurants, K-12 schools, and institutional facilities.

Data for this study includes a culmination of survey data from program participants in 2011, 2012, and the first quarter of 2013. This data is further supplemented by comprehensive surveying of non-participating food service end-users as well as in-depth interviews with program administration staff and participating food service vendors.

What was found in this study was that the market for this type of program is heterogeneous in composition, with a wide range of procurement processing that subsequently require a diverse range of intervention strategies. Examples of segment-specific barriers to program uptake included:

Corporate chain restaurants:

- Use of out-of-state vendors. Corporate chain restaurants (including franchise locations) will typically use a single vendor with a purchase agreement with their corporate headquarters. These vendors are often located out-of-state and thus are generally not reached by program marketing efforts.
- Equipment preapproval lists. Corporate chain restaurants will often have a preapproved list of equipment from which to select. This list at times does not include high efficiency options, and when high efficiency options are included, the guidelines do not speak of possible available incentives.
- Competition with available component retrofit options. The evaluation effort yielded findings that many corporate chains will opt for component retrofits of existing equipment in lieu of installing new high efficiency equipment. This was most commonly associated with burner retrofits in commercial fryers, with savings that are difficult to capture as these retrofits are not subject to the same laboratory testing as found in new high efficiency units.

K-12 Schools:

- Competitive bidding for public sector facilities. K-12 schools in particular are required to put food service procurement out to competitive bid, which often does not factor in the benefits of energy efficient equipment or available incentives, instead making purchase decisions based on lowest upfront cost.
- Approvals through different channels than most equipment retrofits. Most equipment decisions are made by district maintenance departments, who are the primary targets of outreach from most public partnership programs. Decisions on commercial kitchen equipment are generally made by district nutritional departments that may be overlooked in school district outreach.

Independently-Owned Restaurants:

- Competition from the secondary market. In this evaluation effort it was found that the decision-making process for many independent restaurants was between incentivized high efficiency options or purchases of used equipment on the secondary market. With this in mind, the upfront cost comparison (as well as relative gains from the high efficiency option) differs sharply from publicly available ENERGY STAR® estimates.

Given these barriers, effective food service program design should be flexible in allowing program offerings to be seamlessly integrated into the varying procurement processes. The poster summarizes these approaches as well as their strengths and weaknesses in transforming the target market. The poster summarizes several mitigating strategies, including:

- Third-party rebate sign-over, allowing for the integration of rebates into competitive bids.
- Targeting of corporate decision-makers in achieving amendments of equipment eligibility lists.
- Targeted outreach to rebate consultancies in order to ensure program awareness when corporate chains prioritize their purchasing decisions
- Identification of field-measureable performance metrics for food service equipment, to allow for the possibility of incentivizing component retrofits.
- Use of marketing comparing energy cost and O&M savings against secondary market units rather than new standard efficiency equipment.

The mitigation strategies are summarized with an analysis of benefits, drawbacks, and market applicability. Further, these strategies are evaluated on the basis of cost and difficulty of implementation relative to traditional outreach approaches.

New and Improved! Findings and Implications from a Baseline Energy Appliance, Equipment and Building Characteristics Study

Martha Thompson, Evergreen Economics
Tami Rasmussen, Evergreen Economics
Chris Ann Dickerson PhD, CAD Consulting
Jim Flanagan, Jim Flanagan Associates
Merissa Sakuda, Hawaii Public Utilities Commission

Summary

This poster presents results from a baseline energy appliance, equipment and building characteristics study in Hawaii, one of the most oil dependent states in the nation. The study objective was to collect key components of baseline information that will be used by the state's Public Utilities Commission (PUC) and the Public Benefit Fee Administrator to plan future energy efficiency programs and to support the energy efficiency potential study currently underway. The study also provides data to support measurement of the state's progress towards its Clean Energy Initiative, which is to relieve its dependence on oil by setting goals and a roadmap to achieve 70 percent clean energy by 2030, 30 percent from energy efficiency and 40 percent from locally generated renewable sources.

This effort complements the biennial HECO Residential Appliance Saturation Survey (RASS) that was conducted in late 2012 and baseline surveys conducted by Kauai Island Utility Cooperative (KIUC) during 2012 and 2013. Through the combination of this study and the research conducted by the HECO Companies and KIUC, the PUC is collecting comprehensive electricity equipment and facility characteristics data across Hawaii for both residential and business customers. The study includes a mail survey for businesses, and on-site surveys for both the business and residential sectors and provides updated estimates of the frequency (or saturation) and efficiency levels of electricity-using equipment that are present in homes and businesses.

The poster will include recent, robust baseline equipment saturations and efficiency levels for Hawaii's homes and businesses that are currently being used to inform program planning, evaluation and design decisions. These results and the context in which they are being used should be useful for other energy efficiency program planners, implementers and evaluators across the nation as energy efficiency is increasingly relied upon to meet more aggressive goals.

Assessing and Optimizing M&V Metering Samples and Durations

Isaac, K, Wainstein, ERS

Introduction

This poster presents the results of a research project addressing accurate and efficient meter deployment approaches for program evaluation. In determining metering parameters, evaluators must make assumptions based on limited site information, while depending on engineering expertise and evaluation experience to determine which equipment to meter, metering sample sizes, and duration of logging. Our research focuses on the development of methodologies to determine optimal meter sample size and duration, as these require comprehensive knowledge of equipment operational variability. Results of this study will provide evaluators with an analytical framework for developing an accurate and cost-effective metering and verification (M&V) approach.

Sample Size

Existing statistical algorithms are appropriate for determining sample size when multiple units need to be metered. However, every sampling technique requires an estimate of variation of the equipment population. Evaluators rarely have a substantial analytical basis for this variation because gathering the necessary information requires considerable effort and project budget. For example, calculating a realistic estimate of the variation of warehouse lighting operating hours with fixture occupancy control would require extended observation times, detailed site knowledge, and an initial round of metering.

Our research will analyze metered data from past evaluations to provide applicable expected variations based on simple parameters that evaluators already have on hand. Data will include but not be limited to equipment type, facility sector, and end use. Our research will also provide the confidence of each expected variation, thereby providing evaluators with the ability to report an accurate level of error in their metering results. Absent this, stating that metered data was sampled at a confidence and precision of 90/10 can be irrelevant if there is a high percent error in the variability assumption.

Metering Duration

Regardless of whether sampling is necessary to the metering strategy, evaluators must always determine the duration of metering deployment. To determine an optimal metering duration based on weekly, monthly, and seasonal variations requires detailed and accurate knowledge of operating parameters, which is often unrealistic. For example, when evaluating the installation of a VFD on a fan, it is improbable that a site contact will have a grasp of all the parameters that affect fan speed. Without an initial metering period, an evaluator must use knowledge from similar installations to predict the variability throughout the year.

Our research will analyze metered data from past evaluations to determine how the precision and confidence of annual extrapolation vary as the metering period increases. This analysis will be based upon parameters such as equipment type, business type, and end use. Our results will enable evaluators to plan for and optimize metering durations while also facilitating implementation of unique metering durations across multiple sites.

Summary

Our paper will present analytical data and a deployment methodology for optimizing M&V meter installation samples and durations that will enable evaluators to ensure cost-effectiveness while improving the accuracy of reported results.

Demand Response and Appropriation of Smart Grid by Residential Consumers

Greg Wallenborn, Université Libre de Bruxelles - Belgium

Introduction

Residential consumers are one of the main unknowns of smart grid development. They are however often considered as important actors, or co-managers of the grid. Smart metering (SM) and demand response (DR) are the main elements through which consumers are today involved in smart grids. DR refers to different actions that can be taken by consumers to modify their electricity usage in response to a signal that reflects special conditions within the electricity system (such as high prices or risk of grid congestion). Residential consumers represent a large potential of peak shifting/shaving, although its dispersion entails high transaction costs. Consumers are certainly *involved* in the grid, but how to *engage* them in its management?

This poster assesses DR instruments from the point of view of households. Residential consumers are regarded as an assemblage of appliances and human(s). Uncertainty about "who should do what and when" arises partly from this distributed agency, but also from the diversity of consumers' interests in energy management. It is important to observe the theoretical assumptions that frame DR instruments: approaches will vary whether consumers are considered as rational, comfort seekers or experimenters.

How to Assess DR Potential for Residential Consumers

The demand response potential depends on three factors: the shifted power by action taken, the number of actions in a household and the number of involved households.

The number of involved households asks the question of recruitment. As the smart metering case shows, people who opt in for participating to pilot project represent about 5-10% of the total population and are consumers already interested in energy management. Results from these pilots are then biased and cannot been directly generalized to the whole residential sector.

The success of DR programs depends also on how consumers will react to different DR tools and which actions will be taken. DR tools are today mainly economic (e.g. dynamic pricing) and technological (direct load control), and rest upon contradictory figures of consumers (rational or lazy). Furthermore, the number of actions is limited to appliances that use a big amount of power (HVAC; hot water). Other appliances (dishwashers, washing machines, fridges, etc.) are considered as a future target whereas their DR potential is not clear.

Power reduction for each action is usually the result of a trade-off between economical incentives and comfort reduction. We have to notice that DR does not lead generally to energy conservation but rather to load shift.

In the perspective of increasing intermittent sources of electricity, we can view DR as the beginning of a deeper involvement of consumers in grid activities. However, as the value of electricity will be increasingly time-dependent, it is crucial to design new tools in order to enroll users that may have different interests in energy management. In surveys and in practices, residential users show a diversity of reasons to be interested: environment conservation, technology trial, energy autonomy, etc. Current DR programs clearly lack other than economic approaches to convince consumers that they are part of the grid.

Potential and Pitfalls with Quality Installation Verification

Cheryl Winch, Cadmus, Anna L. Carvill, Cadmus

Introduction

This poster explores the verification of baseline technical assumptions behind a high efficiency air conditioner quality installation program. By comparing data gathered through both contractor self-report as well as on-site visits, we found differences between how contractors report their quality installation (QI) procedures and actual on-site measurements.

Methodology

Cadmus surveyed 15 nonparticipating contractors, asking detailed questions about their practices administering the QI components. We weighted responses by sales to derive component-level freeridership values. Cadmus then used the relative savings attributable to each QI component to find an overall QI freeridership value of 55.3%.

Cadmus also used results from site visits to 18 homes with recent high efficiency non-program AC installations to determine the prevalence of QI compliance from nonparticipating contractors. That analysis yielded a failure rate for each component. Homes that satisfied the QI requirements received a passing score, and were the basis for the freeridership value. Cadmus then used the weighted savings attributable to each of the QI components to find an overall QI freeridership value of 54.2%.

Although the overall freeridership value based on self-report was virtually the same as the value derived from field measurement, we found significant differences at the component level. As shown in Table 1, the contractors we surveyed believed they were conducting a proper load calculation and duct sealing at a higher rate than what we found in the field during home visits. Conversely, contractors were under-estimating the frequency of dry bulb and wet bulb recording.

Table 1. Self-Report and Field Measured Quality Install Freeridership Comparison

Quality Install Component	Self-Report Freeridership	Field Measured Freeridership
Load Calculation	58.9%	22.2%
Dry/Wet Bulb	32.0%	77.8%
Refrigerant Charge	57.7%	50.0%
Duct Sealing	87.6%	50.0%
Total	**55.3%**	**54.2%**

This poster will explore implications for how these differences affect contractor perceptions of the installation work they do and their actual installation practices. Further we suggest ways to address the perception gap with participating contractors to improve their quality installation practices. This evaluation resulted in specific topics for contractor training on QI, communication strategies with HVAC installation contractors, and some program design changes resulting in greater savings for the program.

Measurement and Verification Methodology for Coal Fired Power Plant Energy Efficiency Improvement

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Xiaohua Xia, University of Pretoria, Pretoria, South Africa
Jiangfeng Zhang, University of Pretoria, Pretoria, South Africa

Summary

Energy efficiency improvement at existing coal fired power plants is one of the most cost effective ways to solve the energy shortage problem. Stakeholders from the power plants are interested in quantifying the improved performance such as the capacity increases, coal savings and environmental impacts. These impacts can be verified by an independent measurement and verification (M&V) inspection body credibly and transparently.

In this poster, a cost-effective and reliable M&V methodology to evaluate the Energy Efficiency (EE) performance enhancement in power plants is presented. To illustrate, the savings verification for EE improvement interventions that are completed at a power plant, located in Mpumalanga, South Africa, which has six 500 megawatt (MW) units with turbine Maximum Continuous Rating (MCR) at 36.90%, is taken as a case study. The EE improvement project in this power plant entails the identification of the plant EE improvement opportunities through the gathering and analysis of the real time process data for two seasons (winter and summer) to determine the significant contributors to the deterioration of the plant heat rate. EE improvement solutions to the entire plant, including the primary energy, boiler, turbine and auxiliaries, are proposed to reduce the heat loss wherever applicable.

The objective of M&V is to measure and verify the coal savings and the equivalent electricity savings that will occur due to the EE improvement strategies in the power plant. In order to reduce M&V cost and complexity, historical operational data for each of the six generation units such as the generated and sent-out power, coal consumptions, calorific values (CV) of the consumed coal, ambient temperature, etc., during the baseline period are analyzed to build both the coal consumption baselines and the sent-out power baselines for each generation unit. After the implementation of the EE interventions, the sent-out power will increase while consuming same amount of coal or the coal consumption will be reduced while producing the same sent-out power. To evaluate the coal and equivalent electricity savings, energy models are identified to characterize the accurate relationship between the coal consumption and the sent-out power.

After the implementation, the coal consumption, coal CV, the generated power and the sent-out power are also monitored. In the meantime, the energy models are applied to retrieve the amount of coal that would have been consumed without the EE interventions. The coal savings due to the EE interventions are the differences between the retrieved coal consumption and the measurement coal consumption. The coal savings can be easily translated to electricity savings by the established energy models. The M&V methodology is also applicable to other similar power plant EE improvement projects.

Measurement and Verification Methodology for Coal Fired Power Plant Energy Efficiency Improvement

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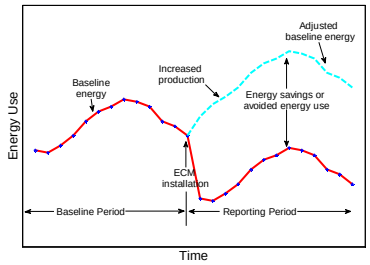
1. Introduction

This poster introduces a Measurement and Verification (M&V) methodology for the savings verification of an energy efficiency (EE) improvement project to be implemented at a coal fired power plant in South Africa. M&V is an impartial, credible, transparent and replicable process to assess the energy savings for the energy efficiency activities. A general M&V methodology is illustrated in Figure 1. The proposed M&V methodology verifies the achieved energy savings by analysing and comparing the plants' online operational data both in the baseline and post-implementation period. This energy efficiency improvement verification approach is inherently cost-effective and more reliable to reflect the actual power plant efficiency than the design values or the results from short-term test under ideal conditions.

Figure 1. General M&V methodology

(Source: International Performance M&V Protocol 2012)



2. Scoping study

The studied power plant was completed and commissioned in 1979. The plant has six 500 MW independent generation units, Unit 1-6, with designed efficiency at rated turbine Maximum Continuous Rating (MCR) of 36.90%.

The proposed project activities to be implemented in the power plant aim to improve the current unit heat rate by 1% after identifying the energy efficiency enhancement opportunities through internal energy flow analysis. The EE activities will be performed for the primary energy, the boiler, turbine and the auxiliaries as well at the power station. Some major retrofitting and refurbishing EE improvement technologies are listed in Table 1. The EE improvement project is commenced from May 2012 and the planned project duration is 3 years.

Table 1. Planned Energy Efficiency Activities

	Energy Efficiency Activities
Primary energy	Improve imported coal quality
	Fix boiler and turbine passing valves
Boiler	Replacement of creep damaged pipework
	Conduct air heater leakage tests and raise defects for repair of air ingress
	Optimise air/fuel ratio in the mills
Turbine cycle	Improve high main and boiler feed pump turbine condenser backpressures
	Re-tube main and boiler feed pump turbine condensers
Electrical	Implement energy efficient lighting project
	Condensate extraction pump variable speed driver retrofit
	Switch off conveyor belts that are not coaling

3. M&V plan

The M&V plan plays a key role in the whole M&V process and gives the complete procedure for the savings evaluation of an EE project.

M&V options: Option C, **whole facility measurement** is selected for this M&V project since the savings contributed from individual intervention are not easy to be isolated for each power generation unit.

M&V boundaries: Six sub-boundaries are defined to be each generation unit of the studied power plant. The project boundary is the summation of the six sub-boundaries. Only the savings inside the boundary will be reported by M&V.

Metering plan and data requirements: Note that there is always a trade-off between the desired measurement accuracy and the M&V cost. In order to control the metering cost, the plant's operational data from both the baseline and post-implementation period are collected to establish the baseline and calculate the savings. In this project, the following data throughout 2011 are adopted for the baseline development:

- Hourly sampled coal consumption per unit;
- Daily sampled CV values per unit;
- Hourly sampled sent-out power per unit;
- Hourly sampled generated power per unit.

Baseline: Both the sent-out power increase and corresponding coal savings can be expected for this project. Therefore, both the power and coal consumption baselines are established for each generation unit. Without loss of generality, baseline development for Unit 1 in January 2011 is taken as example to illustrate the detailed baseline methodology. Let $C_d(i), \mathrm{d} = 1, 2, \ldots, 31, \mathrm{i} = 1, 2, \ldots, 24$ denote the coal consumption at the i-th hour on the d-th day in January 2011; $S_d(i)$ and $G_d(i)$ denote the sent-out and generated power, respectively. CV_d denote the daily calorific value of the coal. The average daily baseline in January for the coal consumption can be calculated by

$$C(i) = \frac{\sum_{d=1}^{31} C_d(i)}{31}. \quad (1)$$

When replace $C_d(i)$ by $S_d(i)$ or $G_d(i)$ in Eq. (1), the sent-out and generated power baselines $S(i)$ and $G(i)$ can also be obtained. Baselines for Units 2-5 in other months in 2011 are also developed similarly for this project.

Baseline adjustments: At post-implementation period, say in January 2013, the coal consumption $\widehat{C_d}(i)$, sent-out power $\widehat{S_d}(i)$, generated power $\widehat{G_d}(i)$ and the coal calorific value $\widehat{CV_d}$ can also be obtained. Let $Q(i)$ be the thermal energy from the coal burning and $Q(i) = C(i) \times CV$. The ratio

$$h_s = \sum_{i=1}^{24} S(i) / \sum_{i=1}^{24} Q(i),$$

the adjusted sent-out power

$$\hat{S}(i) = h_s \times \widehat{C_d}(i) \times \widehat{CV_d}, \quad (2)$$

and the adjusted coal consumption

$$\widehat{C_{sd}}(i) = \widehat{S_d}(i) / (h_s \times \widehat{CV_d}). \quad (3)$$

By using Eq. (1), the adjusted sent-out baseline $\hat{S}(i)$ and adjusted coal consumption baseline $\widehat{C_s}(i)$ can be obtained. The adjusted generated power baseline $\hat{G}(i)$ and adjusted coal consumption baseline $\widehat{C_g}(i)$ are also obtained similarly.

Savings calculation: In this project, both the savings from the sent-out power increase and the savings from the reduction of internal power consumption are reported. Specifically,
Sent-out power increase: $\Delta P_s(i) = \hat{S}(i) - \tilde{S}(i)$.
Coal savings related to sent-out power increase: $\Delta C_s(i) = \widehat{C_s}(i) - \hat{C}(i)$.
Internal power consumption reduction:
$\Delta P(i) = [\hat{G}(i) - \hat{S}(i)] - [\hat{G}(i) - \tilde{S}(i)]$.
Coal savings related to internal EE improvement:
$\Delta C(i) = [\widehat{C_s}(i) - \hat{C}(i)] - [\widehat{C_g}(i) - \hat{C}(i)] = \widehat{C_s}(i) - \widehat{C_g}(i)$.

Note that the savings should be calculated for the same month across the baseline and post-implementation period to guarantee fair comparison.

4. Sent-out power performance assessment

By the implementation of the EE interventions, the plant will generate and send out more power while consuming same amount of coal or the coal consumption will be reduced while producing the same output. The intervention to repair the air heater leakage on Unit 5 is completed in December 2012. The expected savings for this intervention is 20 MW. The performance for this intervention will be assessed 3 times in 3 subsequent months. The sent-out power baseline and post-implementation load profiles, performance summary and the time-of-use savings figures are given in this section.

Figure 2. Sent-out power load profiles

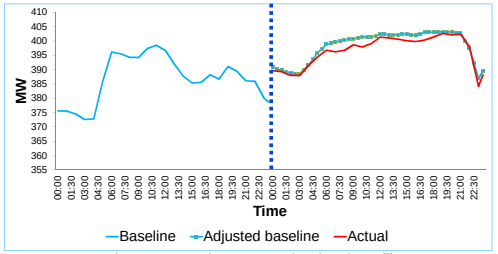


Figure 3. Coal consumption load profiles

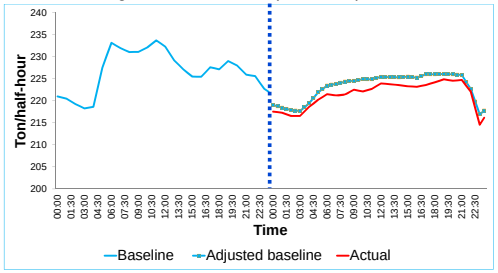


Table 2. Performance summary in January 2013

Description	DSM target	Reporting period	YTD	ITD
Weekday evening peak average demand impact (kW)	n/a	1.03	0.04	1.03
Energy consumption impact (MWh)	n/a	938.9	938.9	938.9
Coal consumption impact (kton)	n/a	1.05	1.05	1.05

Table 3. Average time-of-use sent-out power savings

	Weekday (MW)						
	Morning Off-peak	Morning Standard	Morning Peak	Midday Standard	Evening Peak	Evening Standard	Off-peak
Baseline	391.17	398.92	400.32	402.12	403.12	402.20	391.46
Actual	390.38	396.62	397.31	400.12	402.10	401.62	390.30
Impact	**0.78**	**2.29**	**3.01**	**2.00**	**1.03**	**0.58**	**1.16**

	Saturday (MW)					Sunday (MW)
	Morning Off-peak	Morning Standard	Midday Off-peak	Evening Standard	Evening Off-peak	Off-peak
Baseline	392.27	400.75	402.36	403.12	396.83	398.22
Actual	391.27	397.94	400.53	402.10	395.96	396.66
Impact	**1.00**	**2.81**	**1.83**	**1.03**	**0.87**	1.56

5. Internal EE performance assessment

After fixing the air heater leakage on Unit 5, less thermal energy is wasted for the power generation than that in the baseline period. Therefore, the auxiliary devices for Unit 5 will work less harder and consume less electrical energy. Therefore, besides the assessment of the sent-out power performance, the internal EE performance is also evaluated. The internal power baseline and post-implementation load profiles, performance summary and the time-of-use savings figures are given in this section.

Figure 4. Internal power consumption load profiles

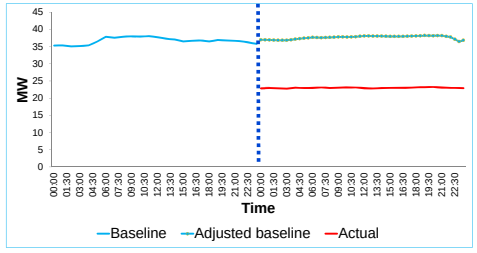


Figure 5. Coal consumption load profiles

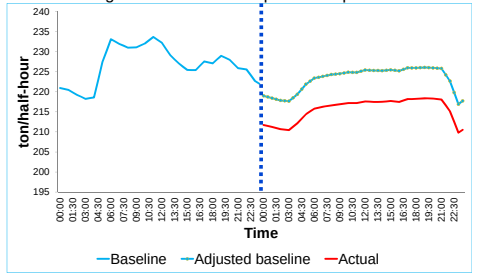


Table 4. Performance summary in January 2013

Description	DSM target	Reporting period	YTD	ITD
Weekday evening peak average demand impact (kW)	n/a	14.98	0.63	14.98
Energy consumption impact (MWh)	n/a	8788.2	8788.2	8788.2
Coal consumption impact (kton)	n/a	4.54	4.54	4.54

Table 5. Average time-of-use power savigns

	Weekday (MW)						
	Morning Off-peak	Morning Standard	Morning Peak	Midday Standard	Evening Peak	Evening Standard	Off-peak
Baseline	37.06	37.65	37.71	37.98	38.17	38.12	37.05
Actual	22.92	23.00	23.05	22.99	23.19	23.12	22.96
Impact	**14.14**	**14.65**	**14.66**	**14.99**	**14.98**	**15.00**	**14.09**

	Saturday (MW)					Sunday (MW)
	Morning Off-peak	Morning Standard	Midday Off-peak	Evening Standard	Evening Off-peak	Off-peak
Baseline	37.14	37.77	38.02	38.17	37.59	37.65
Actual	22.93	23.07	22.96	23.19	23.04	23.01
Impact	**14.21**	**14.71**	**15.06**	**14.98**	**14.54**	**14.65**