Integrating Process and Impact Findings to Understand and Measure Behavioral Savings at Work

Linda Dethman, Cadmus, Portland, OR
Jim Stewart, PhD, Cadmus, Portland, OR
Kathryn Thomsen, Cadmus, Portland, OR

ABSTRACT

Energy related behavior-change programs in the workplace, those that focus on changing mostly habitual employee behaviors, are relatively new despite their potential to save substantial amounts of energy—5% or more. One barrier to implementation is that uniform methods for measuring energy savings and evaluating effectiveness do not yet exist. This paper explores the successes and challenges of assessing these types of programs and the lessons learned. At the heart of the discussion, the authors examine their recent experience with evaluating two workplace behavior-change pilot programs in the Northwest. Of particular interest to the authors was how to effectively integrate impact and process evaluation components to provide a better picture of potential program improvements and resulting performance.

Introduction

Cadmus recently completed impact and process evaluations of two workplace behavior-change initiatives: BC Hydro's Workplace Conservation Awareness (WCA) initiative and the Snohomish County Public Utility District (SnoPUD) Behavior Based Energy Efficiency (BBEE) pilot. The WCA initiative has worked for several years with its large commercial customers to support a wide variety of internal energy champion activities. Its goal was the creation of an internal culture of conservation. The BBEE pilot featured an orchestrated four-week competition period to effect energy-related behavior changes, followed by a four-month persistence period, among 10 Starbucks stores. Program implementers installed on-site and interactive energy monitoring and feedback equipment and instituted on-going behavior-change interventions.

While the programs have significantly different designs, each focused on changing behaviors that are largely habitual and have low financial costs, such as turning out the lights when leaving the room or shutting off equipment, such as computers, when not in use. Each also hoped to influence persistent behavior changes. To examine the effectiveness of the behavior-change initiatives and a reliable means to measure energy savings, and to explain them both, this paper examines these key research topics:

- What is the best approach for producing insightful evaluations of behavioral programs in the work environment, including reliable estimates of behavioral savings involving a diverse set of commercial buildings (that is, retailers, hospitals, schools, property management firms)?
- What are the key program features for successful behavior-based interventions in the workplace?
- How can we link the results derived from the impact evaluation to process evaluation results in order to explain the level of savings achieved?
- How do the behavioral programs affect the organizational culture related to energy efficiency, sustainability, and building an environmental ethic?

The results of these initiatives' impact evaluations revealed evidence of savings from the behavior changes in the workplace. For WCA, the building's energy savings varied widely by sector, ranging from 1%

to 8%, with property management, schools, and municipalities showing the most promise. Savings for the BBEE program averaged between 2% and 4% depending on the measurement methods.

Results of the process evaluations revealed compelling backstories for the participant organizations about the challenges energy champions faced, why savings across organizations (and sectors) vary, and the degree to which the behavioral initiatives influenced environmental consciousness and produced unintended effects—such as building a sense of workplace "community." The process evaluation findings gave a good indication of how the level and type of effort varied, and how these factors, along with different types of feedback and reinforcement, affected participant behaviors.

The following sections examine the process and impact methodology and results of the WCA and BBEE behavioral change initiatives and of other case studies found in literature. The authors compare the successes and lessons learned that might contribute to improved program performance of behavioral change initiatives. To conclude this paper, the authors will demonstrate how to integrate process and impact evaluation methods and apply principles from an "evaluability assessment" to ensure that there will be results, which can be both measured and verified.

Overview of Workplace Conservation Awareness Initiative

BC Hydro offers the Workplace Conservation Awareness (WCA) initiative as part of its Power Smart Partner (PSP) Program. WCA, which began as a small pilot in 2007 with 10 commercial customers, encourages workplace activities that promote conservation through behavior changes related to energy use. In 2010, the initiative expanded to 30 large commercial customers representing approximately 300 sites in six sectors: advanced education, K-12 schools, healthcare, municipalities, property management (office buildings), and retail/hospitality.

BC Hydro developed the WCA initiative based on best practice research, principles of Community Based Social Marketing (CBSM),[1] and assistance from local consultants familiar with similar behavior-based programs. The basic framework for WCA activities for each participating organization involves a planning workshop, marketing assistance, and promotional materials. Each participating organization is assigned a consultant to help with planning, implementation, and reporting. BC Hydro offers an incentive to the participating organizations to help offset the costs of that year's participation.[2]

To participate in the WCA initiative, each organization must complete several steps to plan, launch, and implement WCA activities. BC Hydro requires participants to complete the following steps and activities throughout the course of the year:

- Obtain senior management buy-in and support.
- Assemble key players (energy champions) to participate in the initial planning workshop and to organize events and activities.
- Assemble a green team to plan targeted behaviors and deploy specific initiative activities.
- Develop and conduct pre- and post-participation surveys to gauge existing behaviors and attitudes toward conservation.
- Create a proposal and plan for carrying out the activities.
- Launch events to promote the initiative activities throughout the year.
- Submit quarterly progress reports to BC Hydro.

[1] CBSM uses systematic marketing approaches, along with other concepts and techniques, to influence specific behaviors to achieve a social good, in this case, energy efficiency.

[2] In 2011, BC Hydro offered $5,000 for participating organizations. In 2012, this was modified to not exceed a cap of $15,000, or $0.15 per kWh saved based on projected savings target.

Each organization must develop and promote targeted conservation behaviors through a series of events during the year. Events vary by organization and may include daily, weekly, and/or monthly activities, contests, and challenges designed to encourage employees to reduce their energy consumption. The organization then promotes these events through e-mails, newsletters, posters, or other media campaigns. Employees may be recognized or awarded prizes for achieving conservation pledges or reducing the most energy.

The energy-conservation behaviors targeted through WCA events may include:

- Turning off lights when not in use.
- Making use of natural light or adjusting lighting levels to match needs.
- Adjusting blinds to deflect heat in the summer and retain heat during the winter.
- Turning off computers and computer monitors when not in use.
- Turning off photocopiers, printers, and other machines and office equipment when not in use.
- Unplugging laptops and cell phones when not charging.

Evaluation Approach

Cadmus conducted an impact and process evaluation of the WCA initiative, in 2011, to assess its energy-efficiency savings and to understand its influence on energy-efficiency behaviors in the workplace. In the evaluation, Cadmus also sought to identify key indicators contributing to the success of the initiative, areas that could be improved, and any activities and behaviors that could help explain differences in savings among participating organizations.

The objectives of the evaluation were to:

- Estimate the net electricity savings impacts of the WCA initiative in fiscal years (FY) 2011 and 2012.
- Test the hypothesis that net savings equaled 5% of consumption.[3]
- Investigate building occupant awareness, satisfaction, knowledge, attitude, and conservation actions that result from the initiative.

Cadmus collected monthly data on site energy consumption, weather, Power Smart Partner Program savings, and the implementation of a conservation rate for Large General Service (LGS) customers in the six commercial sectors. Cadmus also collected data for WCA nonparticipant buildings in the property management, K-12 schools, and municipalities sectors.

Cadmus then assembled the data in a panel for regression analysis and estimated the initiative's gross savings with a regression of year-over-year differences in participant monthly consumption (DPC). The DPC model uses participant consumption data from before and during the initiative. We estimated the initiative net savings with a difference-in-differences (D-in-D) regression model of monthly consumption. The D-in-D model uses participant and nonparticipant data from before and during the initiative, and it controls for unobservable factors that were potentially correlated with WCA activity, such as naturally occurring energy efficiency, trends in occupancy, or patterns of business activity. We conducted statistical tests of the assumptions underlying our models and the robustness of the savings estimates.

To evaluate the effectiveness of the initiative's delivery, Cadmus conducted interviews with 12 WCA staff and BC Hydro key account managers (KAMs) and with eight outside consultants. In addition, we interviewed 30 energy champions—individuals who played key roles in coordinating initiative activities,

[3] The *ex ante* savings estimate for new projects is 5% of occupant controllable consumption, which is based on additional data collected about the building systems by participants, consultants, and key account managers. BC Hydro made this change in F2012.

leading green teams, and reporting on WCA activities—within 22 of the 30 organizations that participated.[4] During these stakeholder and energy champion interviews, Cadmus gathered perspectives about the initiative's planning, implementation, and reporting. In addition, we gathered respondent insights about initiative effects, satisfaction, motivations and barriers, and opportunities to improve initiative design, marketing, and implementation.

Cadmus also collected and analyzed information from the WCA participants' quarterly reports, pre- and post-participation surveys, and recorded event data. These sources were useful for assessing the building occupants' awareness and attitudes and identifying key activities contributing to the outcomes of the WCA initiative.

Evaluation Results

The impact evaluation suggests that the WCA initiative saved energy in FY2011 and FY2012, and these savings were positive in most years and for most sectors. However, wide error bounds also meant it was often not possible to reject the hypothesis of zero savings. The initiative achieved positive gross savings in the property management, K-12 schools, municipalities, and advanced education sectors after controlling for the new LGS rate, participation in other BC Hydro energy-efficiency programs, and weather. Gross savings rates in the first and second initiative years ranged between 1% and 8% in these sectors.

Despite best efforts, savings could not be estimated precisely because: (1) the savings were small relative to consumption; (2) information about site occupancy and business conditions was not available for all participants; and (3) the initiative enrolled a relatively small number of sites in each sector. Because of this uncertainty, the savings estimates should be interpreted with caution.

Results of the process evaluation demonstrated that the organization's energy champions were excited about reducing energy and promoting energy conservation through behavior in the workplace. They reported that the behavior-change initiative enhanced many environmental initiatives at their organizations. They also believed the WCA produces energy savings in addition to energy-efficiency retrofit installations. During the evaluation, the energy champions identified some opportunities and challenges of the behavioral initiative. These include:

- Visible senior management buy-in and continued support is critical to ensure sustained involvement from green team members and building occupants. In addition to direct engagement in the initiative's activities or events and in company-wide messages, senior management support could also be demonstrated through sustainability policies.
- Limited funding, time, and staff resources make it difficult to keep up with the demands of launching, implementing, and reporting the initiative activities. Program-funded incentives are important and should match the organization's need for funding and level of involvement.
- Customizing marketing materials for the organization and providing continual messaging to the organization's green teams and the participating employees helps to maintain visibility of the initiative.
- Organizations had limited ability to track energy savings and behavior changes resulting from initiative activities. Although pre- and post-initiative surveys were a requirement of the initiative, logistics made it difficult for organizations to implement and analyze these consistently. Many energy champions stated that they would like to track the targeted behaviors and events but lacked a consistent method, sub-metering resources, or sufficient staff support.

[4] Due to logistical difficulties, including the lack of a database of contacts, we were unable to survey a wider set of building occupants.

- Those organizations with real-time data collection methods, and that were able to report energy savings from the initiative's activities to building occupants and senior management, reported that such feedback generated excitement, additional support, and initiative visibility throughout the year.

Overview of Behavior Based Energy Efficiency Pilot

The Snohomish County Public Utility District (SnoPUD) commissioned Cadmus to evaluate its Behavior Based Energy Efficiency (BBEE) Pilot program. The BBEE featured a four-week competition period to save energy, followed by a four-month persistence period, among 10 Starbucks stores. SnoPUD's goals for the pilot were to save energy through changing employee behaviors and to develop a measurement and verification (M&V) protocol to assess behavior-based energy-efficiency savings in small commercial buildings. SnoPUD and its partners (the project team) hoped the pilot would inform the design of a larger behavior-based program.[5]

SnoPUD's project team implemented the BBEE Pilot between July and December 2012. Throughout the entire pilot period, the project team encouraged employee engagement, provided real-time feedback on energy use via in-store dashboards, and provided energy-savings tips and education to each store. The project team's interactions with store employees were greatest during the competition period and decreased considerably during the persistence period.

Starbucks informed the selected store managers of the pilot during a conference call, presenting an overview of the competition, and delivered collateral material. The collateral included information about tuning-up the store HVAC system, which could be done at the discretion of the store manager. The project team then installed an energy-use dashboard in the back room of each store and asked store managers to explain the competition to their employees. As part of the pilot requirements, each store manager recruited an in-store efficiency champion, introduced the dashboards, and distributed pre-competition surveys.

During the four-week competition period, the project team and the store managers and partners communicated via the energy-use dashboard. The dashboard was designed for two-way communications, providing savings tips and accepting feedback and suggestions. The in-store champions used the dashboard to provide the project team with status reports, including the actions partners took in response to the tips. When the competition period concluded, Starbucks conducted an action review with store managers and partners to gather feedback, insights, barriers, and lessons learned.

The dashboard, however, remained in the stores for another four months. During this persistence period, the project team continued to encourage partners to take efficiency actions through energy-savings tips and performance feedback.

Evaluation Approach

The objectives of the BBEE process and impact evaluation were to:

- Validate the gas and electricity savings during and after the competition period and assess the M&V approach used by the project team.
- Provide further insights about the ability of the chosen behavioral interventions (that is, competition, feedback, employee engagement, and energy tips) to influence energy savings, and determine whether the participating stores experienced any other benefits.

[5] SnoPUD partnered with Starbucks, Puget Sound Energy (PSE), Lucid, and PECI to implement the BBEE pilot in 2012.

The BBEE Pilot was designed and implemented as a quasi-experiment. The project team selected 10 Starbucks stores in SnoPUD's service territory to participate in the pilot and measured an energy consumption baseline about six to eight weeks prior to the launch. Participants were selected on the basis of store type, building vintage, size, and Starbuck's district manager territory. After the pilot period was over, the project team selected a control group of 58 Starbucks stores in Puget Sound Energy's (PSE) service territory (adjacent to SnoPUD's territory) to control for naturally occurring efficiency and changes in store sales. The primary criteria for control group eligibility were the availability of daily energy use data, data quality, heating fuel, and building characteristics. The project team selected a research design with these features to minimize the impact on store operations and to stay within the pilot budget.

Cadmus reviewed the project team's M&V data and documentation and met with them to learn more about their evaluation process. Cadmus then assessed the project team's M&V approach and savings estimates, focusing on research design, data collection, model specification and estimation, savings estimation, and reporting.

To develop insights about the pilot's operation, Cadmus reviewed participant feedback and program documents and interviewed seven members of the project team to learn more about how the program was implemented, its influence on energy-efficiency awareness and actions, and the lessons learned. Cadmus used these resources to develop recommendations for program improvements.

Evaluation Results

The BBEE impact evaluation results (based on validation of the M&V approach) indicated the project team used an appropriate methodology for estimating savings from behavior change. The team collected data and conducted a regression analysis of hourly or daily energy use for Starbucks stores. Panel regression analysis of electricity use in participant stores indicated that, on average, each participating store saved a little over 4% during the competition period. D-in-D panel regression analysis of the energy use of participant and nonparticipant stores indicated that, on average, each participating store saved a little over 2%, during the competition period. The D-in-D regression estimates control for unobservable, naturally occurring efficiency and changes in business activity; these are the best estimates of the pilot savings.

Although the project team took steps to minimize the potential for unobservable differences between the groups and to ensure equivalence, there may have been differences between the intervention and control stores' other energy-efficiency projects. The project team ensured that there were no other energy-efficiency projects in intervention stores in the baseline and competition periods, but this was not possible in control stores. Because the M&V did not account for this possibility, pilot savings estimates may have been biased downward.

The process evaluation demonstrated that the pilot had varied success at engaging employees to take energy-saving actions. While energy savings varied among stores and the 5% savings goal was not reached, the pilot illuminated key opportunities and challenges for implementing and measuring the results of workplace behavior energy-efficiency programs. The stakeholder interviews reviewed the following insights:

- The visible and continued support from all levels of leadership is a key influence on the success of behavioral programs. Management attention can help overcome resistance to adoption of new behaviors and help ensure that new behaviors persist over time.
- Although the pilot hoped to have employees provide regular feedback through on-line surveys, employees found it challenging to find time for this level of feedback and participation in this activity was limited.
- The competition framework received mixed reviews from store employees. Employees in some stores were glad to engage in friendly competition (and were motivated by it), while others felt defeated by it from the start.

- The lighter support and lower visibility of pilot activities during the post-competition period made many employees think the initiative had ended. These changes in pilot implementation likely decreased the attention to energy-saving actions.
- Program communications—such as providing energy-efficiency tips, messages from management, or progress reports—are most effective when they use communication channels that are already established in the businesses.

Literature Review

To identify characteristics of successful behavior-change initiatives in the workplace, and to describe the methods that recent evaluations have used to assess energy savings, Cadmus conducted a short literature review of initiatives similar to WCA and BBEE. Overall, based upon our review,[6] ongoing energy efficiency initiatives that target occupant behavior in the commercial sector are still rare compared to the number of programs designed to influence changes to high efficiency equipment and operations and maintenance (O&M) activities. In addition, for commercial occupant behavior-change programs that have been evaluated, methods vary widely or may focus more on the process rather than the energy impacts.

Results of the literature review reveal programs with designs and delivery approaches that can vary due to institutional structures and organizational needs. However, we ultimately developed a framework of common traits that includes:

- Use of energy champions or a green teams
- Use of a dedicated energy manager
- Education and training, including for building operators
- Reliance on advanced metering energy management systems that provide timely feedback about facility operation and energy use
- Conventional and social marketing approaches and audience involvement strategies, such as contests and competitions

Overall, we did not find enough studies to conclude what works best to assess the energy impacts of energy efficiency programs targeted to changing the workplace behaviors of commercial building occupants. However, billing analysis and experimental design is evident in several of the studies listed in Table 1 but may be combined with other approaches such as engineering analysis and sub-metering.

[6] Note: This literature review was limited in scope and conducted within a one-week time frame.

Table 1. Summary of Four Relevant Program Evaluations and Methods

National Renewable Energy Laboratory		
Plug Load Behavioral Change Demonstration Project	Study to determine most effective way to reduce plug load energy, under three approaches: (1) auto-control system, (2) letters with tips, (3) competition.	**Experimental Design** • Monitored plug load with sub-metering and control systems • Inventoried plug loads pre- and post-experiment • Established energy use baseline for four weeks with occupant pods of 6-8 people • Tested experimental applications for four weeks • Remove intervention, measure change from baseline, calculate if difference statistically significant using paired T-tests
Northwest Energy Efficiency Alliance		
Behavior Change in the Industrial Sector	Continuous Energy Improvement program systematizes energy management into industry's traditional management structure	**Bottom up (traditional engineering to quantify savings for each measure) and top-down (statistical analysis) approaches** • Examined difference between equipment savings and total savings to determine savings attributable to behavior • Top-down approach examined indicators, such as kWh and Btu use, key production statistics and other variables, such as weather, that allow for a normalization of energy • Individual analyses of site monthly kWh and therm consumption • Baseline energy use—minus capital improvement project savings—is compared with energy use after the company has embedded a management system
Puget Sound Energy		
Resource Conservation Manager (RCM) Program	Funds RCM to focus on O&M behaviors. Salary repaid through savings.	**Billing data analysis, adjusted for capital improvements, change in use, weather and other factors** • Measures annual changes in energy use at facility or portfolio level and compared to previous 12 months • Panel regression analysis of site consumption for each sector • Measures assigned 3-year measure life
Bonneville Power Administration		
Energy Management Pilot Impact Evaluation	Provides long-term energy management consulting services to education and train industrial energy users in energy efficiency	**Billing analysis of whole building consumption with adjustments for capital measure savings** • Individual analyses of site consumption • Detailed data on site production • Savings more likely to be detected with higher frequency (daily or weekly) billing and production data

EDF Climate Core and Boeing

As part of the literature review, the authors also reviewed a short case study about The Boeing Company participation in the Environmental Defense Fund (EDF) Climate Core,[7,8] a summer fellowship program that helps organizations overcome barriers that prevent them from investing in energy efficiency. Climate Core trains business graduates from top academic programs to act as energy champions, solve energy problems, and help the host organization save energy costs and reduce greenhouse gas (GHG) emissions. Climate Core estimates that the program saves companies on average $1 million in energy savings.

The Boeing Company has been increasingly turning to employee engagement to achieve environmental goals, and it support employee recruitment, satisfaction, and retention. To quantify employee's environmental engagement, Climate Core's energy champion created a Web-based tool to collect and quantify environmental actions for manufacturing and office environment. The tool consisted mostly of multiple choice questions (with minimal open-ended entries). Reported results of the employee actions indicated the following benefits:

- Feedback about project impacts helps to motivate teams to complete environmental projects.
- Empowering teams to calculate potential energy and cost savings helps to prioritize projects.
- Ensure that teams will be recognized and rewarded when project impacts are tangible.
- Projects can be replicated in the company when knowledge is transferable.
- Compiling activity data in a consistent format enables the company to collect, aggregate, and report impacts of successful employee-led environmental impacts.

Lessons Learned for Improved Program Performance

Through comparison of the evaluated behavior change pilots and review of the literature, the authors identified some common themes and activities contributing to successful behavioral change initiatives. In addition to establishing a strong step-by-step framework for the program's delivery, success traits involved multiple behavioral interventions such as identifying messengers, obtaining buy-in and commitments, promoting awareness through social norms, and providing employee recognition.

Table 2 lists the common themes and activities that can be incorporated into design and delivery of behavioral change programs to increase likelihood of active participation and realized energy savings. The column on the right shows the impact of incorporating these elements into the design and implementation of the behavioral-based initiatives.

7 Climate Core host organization case studies are provided at the following Websites: http://edfclimatecorps.org/about; http://edfclimatecorps.org/organizations

8 Environmental Defense Fund Climate Core information is at the following Website: http://edfclimatecorps.org/about

Table 2. Qualities of Successful Behavioral Change Initiatives

Program Elements and Activities	Impact on Program Performance
Obtain adequate management buy-in and support at the local, corporate, or district level	Provides more opportunities for consistent messaging, funding, resources, and enables decision-making abilities at green team level
Establish strong messengers, energy champions, and green teams	Provides supportive culture and visible management support (at the local and district level)
Ensure adequate training and communicate pilot expectations through workshops and events	Ensures the pilot goals and processes are understood across staff and management
Hold events, activities, and friendly competitions on a regular basis (daily, weekly, monthly) as appropriate for the audience	Staff members who are motivated by the friendly competition framework, and recognized, are likely to contribute a stronger team spirit
Provide frequent messaging through customized marketing materials, inner-office communications, emails, newsletters, Website, social media	Increases visibility of the initiative, promotes more employee awareness, and increases likelihood behavior activities will persist
Incorporate messaging in employee handbooks, operational manuals, green policies, teaching curriculum	Builds culture of conservation and promotes savings persistence
Establish tracking and feedback mechanisms such as checklists, sub-metering, building optimization software	Allows savings to be linked to behavioral events and activities, demonstrate success to decision-makers and participants
Ensure results are visible to staff and management and provide frequent interactions with the dashboard	Provides opportunities to build initiative involvement through word of mouth, and generates more excitement, interest, and management support

Evaluability and Measuring Program Savings from Behavior Change

Through the evaluation comparison and literature review, the authors showed that the impact of evaluation approaches in commercial and industrial behavior programs vary and often need to make trade-offs along the dimensions described below.

- **Research design.** Experimental, quasi-experimental, non-experimental. An experimental design approach is generally more effort to set up, may not be possible in many commercial situations, and may make it difficult to determine if pilot programs are scalable. However, if properly done, experiments can make it easier to find savings and infer causality. Non-experimental designs are more flexible and adaptable to real world conditions. However, they demand more careful tracking of multiple variables and will likely create greater challenges for detecting savings and establishing attribution.
- **Analysis of whole-building or sub-meter data.** Whole building analysis is comprehensive because it captures effects of all savings behavior; however, whole building data may be noisy, which may make it difficult to detect savings. With sub-meter data, it is possible to target effects of particular behaviors, but some savings impacts may be missed.

- **Frequency of meter and production data (hourly, daily, weekly, or monthly).** It is generally easier to detect savings with higher frequency data.
- **Length of baseline.** A shorter baseline period is likely to have less variability and noise but is much less likely to reflect real world conditions over time.
- **Individual-site versus panel (pooled) regression analysis.** Panel regression analysis yields an estimate of the savings for the average site. Individual analysis yields an estimate of the savings for each site. The choice of panel vs. individual savings analysis usually depends on the evaluation objectives. In addition, it may be inappropriate to pool industrial or commercial sites in a panel. Differences between sites mean that relationships between energy use and output (for example, food, uranium, wastewater processors) do not always line up neatly.
- **Availability of site production, occupancy, or use data.** Without this data, it can be difficult to detect savings as there will be much more noise in the consumption data.

Cadmus has contributed to development of a systematic approach used in our evaluations to ensure that evaluation data will be available to measure energy savings and program performance. This systematic approach, called an evaluability assessment (EA), commonly involves the following steps:

- Interviews with key stakeholders, program implementers, as well as staff responsible for data collection, storage, and retrieval.
- Review and analysis of available program documents, including the implementation plan, program theory and logic models, marketing plans, and program forms.
- Examination of program forms to assess data elements intended for collection and to compare these to data elements required for later analysis.
- Examination of program data tracking databases to assess the data collection plan, identify data elements recorded in the database, and other elements stored outside the program-tracking database.

The outcome of an EA is the identification of research objectives and indicators needed to enable assessment of a program's performance. Applying the basic principles of the EA, Cadmus has identified some necessary conditions that should exist to enable measurement of the energy savings from behavioral programs.

Table 3 lists the general conditions necessary for accurate measurement of behavioral programs in the left column. These can be incorporated into the planning stages or conducted during the program's implementation. The right column lists the contribution towards the program's evaluation.

Table 3. Conditions Needed for Accurate Measurement of Behavioral Programs

Conditions Needed for Accurate Measurement	Contribution to Evaluability
Identify baselines for building energy savings, and occupant behaviors, attitudes, awareness by collecting data from pre and post surveys	Ensures ability of measuring difference in employee actions and savings resulting from initiative
Establish organizational baseline of adequate length	Allows representation of weather and business conditions for pre and post periods
Track whole-building data such as occupancy rate and business activity for at least 12 months prior and monthly during behavioral activities	Enables M&V to capture entire range of savings impacts

Conditions Needed for Accurate Measurement	Contribution to Evaluability
Collect detailed information uniformly and systematically about behavioral activities such as dates of occurrences, and frequency of behaviors	Provides more granular data improving accuracy of savings impact analysis
Collect higher frequency data (hourly, daily, weekly) site energy data	Increases chances of detecting behavioral activity savings

Conclusions

These conclusions address the key research questions posed at the beginning of this paper:

- No one best approach exists for insightful evaluations of workplace behavior change programs, including reliable estimates of energy savings across diverse businesses. However, we suggest a three-step process that (1) considers key trade-offs in evaluation approaches; (2) includes an up-front evaluability assessment; and (3) adheres to the conditions needed for accurate measurement as described in Table 3 above.
- Key program features for successful behavior-based interventions in the workplace include: strong management support; energy champions; adequate training; frequent activities and messaging; incorporation of desired behaviors into regular business procedures; and regular and visible feedback.
- Linking of impact to process evaluation results to help explain the level of savings has often been weak; it requires making data reporting convenient and important to participants.
- Qualitative data from workplace behavior change programs suggest that organizational culture can move toward a stronger sustainability ethic if steps are taken to ensure consistent support over time, integration into regular business practices, and rewards for actions taken.

References

Cadmus Group. 2010. "BPA Energy Smart Industrial Program: Early Report." Prepared for Bonneville Power Administration. http://www.bpa.gov/energy/n/reports/evaluation/pdf/ESI_Early_Evaluation_Report_20090618_FINAL.pdf

Cadmus Group. 2011. "NEEA Market Progress Evaluation Report #6, Evaluation of NEEA's Industrial Initiative." Northwest Energy Efficiency Alliance http://neea.org/docs/reports/evaluation- of-neeas-industrial-initiative-639c6b786ecd2.pdf

Costa, D.L. and M. Kahn. 2010. "Energy Conservation 'Nudges' and Environmentalist Ideology: Evidence from a Randomized Residential Electricity Field Experiment." National Bureau of Economic Research: working paper 15939.

Friedrich, K., J. Amann, S. Vaidyanathan, and R. Elliott. 2010. "Visible and Concrete Savings: Case Studies of Effective Behavioral Approaches to Improving Customer Energy Efficiency." American Council for an Energy Efficient Economy http://aceee.org/research-report/e108

Giles, D.E.A. 1982. "The Interpretation of Dummy Variables in Semilogarithmic Equations: Unbiased Estimation." Economics Letters10: pp. 77-79.

Halvorsen, R. and R. Palmquist. 1980. "The Interpretation of Dummy Variables in Semilogarithmic Equations." American Economic Review 70: pp. 474-475.

Longland, M. 2007. "Finding Hidden Energy Savings: Operational, Maintenance and Behavioral Savings for Large Commercial Customers." IEPEC Proceedings.

Metzger, I., A. Kandt, and Otto VanGeet. 2011. "NREL: Plug Load Behavior Change Demo Project." National Renewable Energy Laboratory http://www.nrel.gov/docs/fy11osti/52248.pdf

Smith, C., R. Siong, and J. Sandin. 2011. "Impact Evaluation of Behavior Change in the Industrial Sector." IEPEC Proceedings http://www.iepec.org/2011PapersTOC/papers/048.pdf#page=1
Snohomish PUD. 2012. "BPA Behavior Based Energy Efficiency Pilot" Evaluation in progress.
Younger, B., L. Moen, T. Brown, and B. Wilhelm. 2008. "Implementing a Resource Conservation Manager Program at Puget Sound Energy." ACEEE Summary Study on Energy Efficiency in Buildings Proceeding http://www.aceee.org/files/proceedings/2008/data/papers/4_267.pdf