Oh, Behave! Fitting Multi-Sector Behavioral Programs into Utility Frameworks

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ABSTRACT

The Northwest has entered into a new paradigm of energy efficiency with substantial increases in regional energy savings acquisition goals, based on the Northwest Power and Conservation Council's 6th Power Plan[1]. The Plan contains a new focus and direct savings targets for programs that acquire savings through changes in behavior, process, and business practices, particularly in the industrial sector.

The development of behavior-based programs in the context of traditional energy efficiency programs, which are based on single-transaction incentives, has posed numerous challenges for planners, implementers and evaluators. For planning, challenges arise in predicting and reporting the stream of savings over time. Within program design, implementers must construct a program that provides incentives for persistent and permanent savings, requiring a multi-year effort of program resources and communication channels between implementer and end user. For evaluation, questions include the correct evaluation approach, the timing and length of the evaluation, and the reliability of savings over time achieved through behavior. In addition to programmatic challenges, overarching issues arise in regards to the framework of cost effectiveness, measure life and persistence, and uncertainty in performance and supply side impacts.

This paper will cover the above questions in each of the key behavioral programs by sector, and outline BPA's and the Northwest's evolving approach in surmounting these new challenges.

Introduction

The Northwest has entered into a new paradigm of energy efficiency with substantial increases in regional energy savings acquisition goals, based on the Northwest Power and Conservation Council's 6th Power Plan[1]. The Plan contains a new focus and direct savings targets for programs that acquire savings through changes in behavior, process, and business practices, particularly in the industrial sector. Traditional energy efficiency programs have historically approached projects as a one-time transaction with the end user centered around the installation of an efficient piece of equipment with defined or measurable savings and costs; the equipment is installed and the incentive paid in full, cost effectiveness is calculated using an assigned measure life, and first-year savings reported are assumed to remain constant or degrade over time. Once savings are booked and incentives are paid, the project and end-user interaction is considered closed.

Behavior-based programs have introduced new channels for acquiring cost-effective energy savings and require new methods for measuring, implementing, reporting and paying for

[1] http://www.nwcouncil.org/energy/powerplan/6/default.htm

savings. For planning, challenges arise in predicting and reporting the stream of savings over time. Due to uncertainty in persistence, one program option is to pay program incentives over multiple years, which can create a misalignment between reported savings and incentive payments. Other issues include determining and reporting accurate measure lives, and correctly measuring and adjusting for baseline. Without a major paradigm shift in end-user thinking, program designers must construct a program that acquires persistent and permanent savings, requiring a multi-year effort of program resources and communication channels between implementer and end user. For evaluation, questions include the correct evaluation approach, the timing and length of the evaluation, and the reliability of savings over time achieved through behavior.

This paper addresses each of the major challenges in planning, implementing, and evaluating a successful program related to behavioral changes, outlining Bonneville's current approach to overcoming these obstacles, and ensuring persistent and reliable energy savings, recognizing that this area is nascent and that our approaches are likely to evolve in the future.

Beginning with a summary of Bonneville's current behavior-based energy efficiency programs, this paper provides an overview of program structure in the industrial, agriculture and residential sectors. Next, we will focus mainly on the industrial sector to address the major challenges of offering behavior-based programs within the traditional energy efficiency framework, and provide details on how Bonneville has attempted to overcome these issues through planning, implementation and evaluation,. Finally, given the increasing role of behavioral based programs in energy efficiency, should utilities continue to fit behavioral programs within the current framework? Or is it time to revisit the structure of utility programs? This paper will lead us to these underlying questions for further discussion.

Description of Programs

Bonneville Power Administration is a wholesale power marketer in the Northwest with over 140 utility customers. Bonneville has been a leading force in promoting energy efficiency in the Pacific Northwest for the past three decades. Since the early 1980s, BPA and its regional wholesale power customers have acquired cumulative electricity savings of more than 8700 GWh. Bonneville's primary role in the development and acquisition of energy efficiency resources is to facilitate delivery of effective savings opportunities and programs by providing the necessary tools, technical support and financial resources to its regional power customers.

The following sections describe Bonneville's programs that contain behavioral or performance features.

Industrial Energy Management

Bonneville Power Administration, in combination with its program partner Cascade Energy, has designed the Energy Management pilot within its newly developed Energy Smart Industrial program to address the Council's Sixth Power Plan and respond to feedback from industrial end users. The Energy Management pilot component consists of three core features:

Energy project manager co-funding. The goal of Energy Project Manager co-funding is to increase end-user management and engineering efforts devoted to electrical energy efficiency projects and increase the number of projects entering the program. Energy Project Manager co-funding was created to address a commonly referenced barrier to the implementation of industrial energy efficiency projects – namely that the end users are often thinly staffed to the point that energy efficiency efforts (either capital projects or operations and maintenance (O&M) focused efforts) often stall or are never developed due to lack of manpower at the site.

Track and tune projects. The goal of this feature is to provide financial and technical assistance to the end user to “do the little things well” while putting a system in place that allows the overall program and end user to track energy performance and savings over a multi-year horizon. This feature centers on O&M savings and not on typical capital-intensive projects. To achieve solid savings of this type, this feature continuously tracks the performance of the area of focus (whole facility, system or process). This tracking establishes the baseline, shows the effect of the initial tune-up effort, and tracks the performance over time to promote continuous improvement and to guard against backsliding. An energy performance tracking system is put in place to document total O&M energy savings and to remove measure life uncertainty. This methodology was developed to ensure a reliable, long-term source of savings.

Participants in Track and Tune are paid annually for up to 5 years, based on total annual kWh savings measured. Payments are highest in the first year, which is when the facility is likely to see the largest incremental decrease in energy use. Lower incentive payments are provided for years two through five, to support persistence of previously-achieved savings and encourage increased savings. Savings are tracked and measured using sub-metering and whole building metering devices, as well as regression analysis.

High performance energy management. The basic objective of the High Performance Energy Management pilot feature is to assist end users in the adoption of energy management practices. High Performance Energy Management is the application of the principles and practices of continuous improvement to energy management within an end user’s organization. This feature is delivered in coordination with the other technical assistance and financial incentive components of the program.

End users are eligible for a series of annual incentive payments based upon measured savings achieved. The HPEM incentive is applied after savings from other efficiency projects have been accounted for and subtracted from total facility savings annually. The HPEM incentive applies to the saving achieved in the first year, and four subsequent years thereafter.

Agriculture Scientific Irrigation Scheduling

Scientific irrigation scheduling is a process growers of agricultural products can use to improve irrigation water management. When used properly, scientific irrigation scheduling provides information on when to irrigate, how much water to apply, and how to apply water to satisfy crop water requirements and avoid plant moisture stress. When used appropriately, irrigation scheduling saves water, energy, labor, and fertilizer, and in many cases improves crop yields and crop quality.

BPA offers utilities two contractual options for irrigation management: Scientific Irrigation Scheduling (SIS) and Scientific Irrigation Scheduling Light (SISL). Under the SIS program, participation applies to agricultural systems for which there is a pumping capacity beyond what is needed to meet normal crop irrigation needs. Customer participation is accepted with a three year commitment to collect weekly hydro application data including all water applied, evapotranspiration needs and soil moisture tables. The full savings estimated for the acreage are reported in the first year of the commitment and incentives are paid based on dollars-per-acre under management. In the second and third years of the program, incremental savings over the first year are booked (either negative or positive), and constant payments are made for acres-under-management. Due to reports of burdensome requirements for SIS, Bonneville developed a pilot project for SIS Light, which does not require a three-year commitment. Instead, for agricultural systems that have less than 1,000 qualifying acres, energy savings are reported at one-third of the expected savings over three years. With this adjustment, savings are now booked consistently across the measures life of the project.

Residential Behavioral Programs

Programmatic approaches to achieving savings through residential behavioral-based programs have become more popular over the past few years. There are multiple methods that are being tested throughout the Northwest region and by Bonneville utility customers, including in-home feedback devices, energy benchmarking information and community-based programs.

Residential behavior-based programs encourage participants to save energy through changes in behavior (e.g., turning off lights, setting thermostats) and increasing investments in energy-efficiency measures (measures that themselves actually save energy such as heating/cooling equipment). Specific program offerings may include multiple aspects to influence consumer behavior. Programs may offer many types of behavior-based components to customers, including:

- **Energy benchmarking.** Energy benchmarking compares participant consumption to historical consumption or to peers.
- **Feedback devices.** Use of monitoring or metering devices to provide information on instantaneous demand or consumption over time at the whole-house or end-use level.
- **Information and training programs.** The programs provide consumers with basic information on how energy is used in the home, what factors influence energy consumption, and various ways to save. These could include schools-based or community-based programs.

At this time, Bonneville does not have a specific program for residential behavioral programs. Instead, working with a group of Northwest utilities, it has developed evaluation methods for residential behavior-based programs, as discussed below.

Challenges of Behavioral Programs

Behavior-based programs are rapidly growing in popularity as a method for capturing energy savings. As programs develop around the Northwest, new challenges arise in fitting behavioral programs into current efficiency methods for measuring, reporting, marketing, and evaluating savings. These challenges arise because of the structure of current utility efficiency programs and policies. For example, many utilities require that a program or project is cost-effective before implementation is approved. In addition, many utility frameworks for energy efficiency are based upon providing incentives to end-users through rebates, instead of alternative approaches such as changing social norms or altering rate schedules. For the behavior-based programs currently offered by Bonneville, planning, evaluation and programs staff have been working to determine key areas of program challenges, and outline potential methods for success.

Supply Side Issues and Uncertainty in Performance

It is essential in utility planning that we understand the "true" energy savings that are achieved by efficiency programs in order to report accurately their impacts on power supply needs. Therefore, it must be tantamount to develop programs and evaluations that can make certain savings are neither under-estimated nor over-estimated. Further, to accurately report savings, the baseline conditions and the persistence of the savings must be fully understood.

Although there is increased attention throughout the country on behavior-based programs, the research of costs, savings and persistence is in its infancy. This uncertainty creates a tension where there is interest in implementing the programs, but there is insufficient information to understand key drivers of performance such as how much savings will be achieved and how long they will last. Strong research agendas are required for all behavior-based programs in order to verify the quantity and persistence of savings and measure the cost-effectiveness of the efforts.

Estimating & Verifying Savings

Bonneville's programs focus on estimating and verifying savings through ex-ante savings estimates, simplified calculators, site-specific M&V protocols and program evaluation. For behavior-based programs, Bonneville uses a combination of these approaches for estimating savings. For example, the SIS program has an approved calculator which combines some ex-ante input assumptions and site-specific information to estimate savings for each farm. For residential behavior-based programs, Bonneville will take a program evaluation approach.

One of the most complicated and least defined areas for estimating and verifying savings is M&V protocols in Industrial Energy Management. In industrial programs, traditional energy efficiency projects are able to measure savings through the installation of equipment and approved and verified M&V protocols (e.g., IPMVP) which ensure a consistent and reliable method for accurately quantifying energy savings coming from energy efficient equipment. Because behavioral programs do not fit into the traditional M&V paradigm of measuring savings through equipment and process, the Northwest has yet to develop approved M&V protocols to measure savings resulting from changes in behavioral and business practice.

Building on the research of the Northwest Energy Efficiency Alliance (NEEA's) Industrial Initiative in Continuous Energy Improvement[2], BPA's industrial pilot programs have begun the process of determining methods for consistently measuring behavioral energy savings. One of the key factors in accurately estimating savings is to establish a true baseline of energy use prior to the implementation of behavior change. Factors both endogenous and exogenous to energy use must be accounted for in determining baseline usage, including seasonal weather adjustments, load shapes, changes in production, and regular business or personal practices. For example, in industrial facilities, a reduction in production lines can be mistaken for energy savings if baseline energy use is not adjusted for changes in energy use intensity in regular business practices.

[2] http://www.nwalliance.org/ourwork/industrial.aspx

To see changes in baseline energy use, continuous monitoring and tracking is required to measure the amount of reduced energy over time. Unlike energy efficient equipment where savings can be measured immediately after installation and are assumed to persist at a constant level for its' effective life, energy savings through behavior occurs over time with little current understanding of the guarantee of persistence. At any time, changes in behavior or business practice back to the status quo results in the loss of energy savings achieved.

In Bonneville's Industrial Track and Tune program, monitoring, tracking and reporting (MT&R) systems are being created to track baseline usage and measure usage reductions over time, allowing for continuous monitoring of industrial facilities to ensure that savings persist. In cases where energy use increases, the system will signal to end users that savings relative to the established baseline are decreasing and that Track and Tune projects should be completed again.

In many cases, behavioral savings cannot be directly attributed to a specific process, but can be measured on a whole building level as the result of an overall change in practice and overall behavior. Because no single piece of equipment can be measured, regression analysis using the measured baseline data and data collected through monitoring and tracking tools can be used. The use of regression analysis in the Industrial Energy Management program is expected to be the key to measuring savings on the whole building level, recognizing the need for clearer monitoring and evaluation protocols and the difficulty in conducting regression analysis on industrial facilities. A critical piece of accurately measuring energy savings through regression is to account for all known factors which influence energy use, and to develop consistent model structures and criteria for statistical significance.

Estimating Measure Life

With behavioral programs still in their infancy, the lifetime of the savings expected across sectors and programs have yet to be verified and widely accepted with any standard across the industry. Uncertainty in lifetime affects measure and program level cost-effectiveness estimation and affects the way the program has to be structured in order to gain the persistence required to have a cost-effective offering.

For example, to be cost effective from a total resource perspective (Bonneville's measurement of cost effectiveness), it was necessary for BPA's SIS program to be assigned a 3 year measure life, meaning that 1st year savings must persist for at least 3 years, therefore requiring a multi-year participation agreement from the end user. Based on the Northwest Power and Conservation Council's industrial energy savings potential estimates[3], BPA has decided to apply a 10 year measure life to energy management savings, while tracking them for 5 years. For residential programs, the evaluation methods require savings estimation for 3-5 years.

In all cases, robust research is required to verify actual lifetimes for various behavior-based programs and to adjust planning estimates in the future.

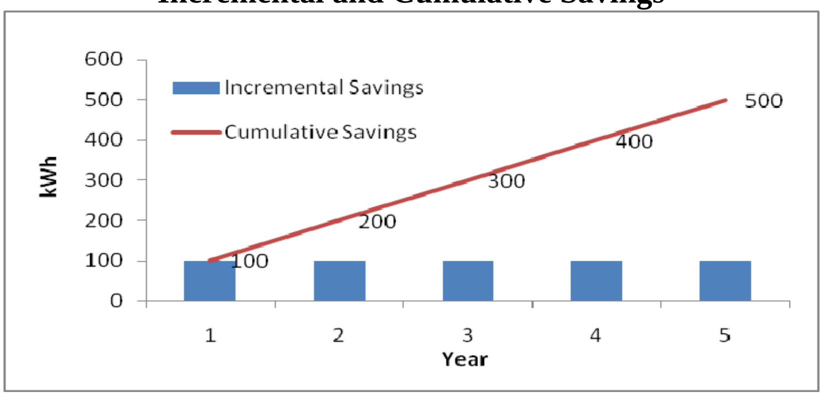
[3] http://www.nwcouncil.org/energy/powerplan/6/supplycurves/ind/Systems%20Optimization%20R9.1rev.xls

Reporting Savings over Time

Once savings are measured and verified they are reported into BPA's energy efficiency database. Energy savings in this database are reported as first-year annual incremental savings. That is, the system is based on reporting savings for newly installed measures and therefore annual achievements reported by BPA to senior management and the Northwest Power and Conservation Council are incremental, rather than cumulative, savings.

The following figure graphically shows the difference between incremental and cumulative savings, assuming that five measures with savings of 100 kWh/measure and a 5-year measure life are installed in each year for five years. Bonneville would report 100 kWh in each year as achieved savings, representing the new or incremental savings in addition to savings already reported in previous years. Because savings are assumed to persist at a constant level for the life of the equipment, no adjustments to reported savings are required once entered into the database. The cumulative savings account for measure life, such that by year 5, there are 500 kWh of cumulative savings that are saved.

Incremental and Cumulative Savings



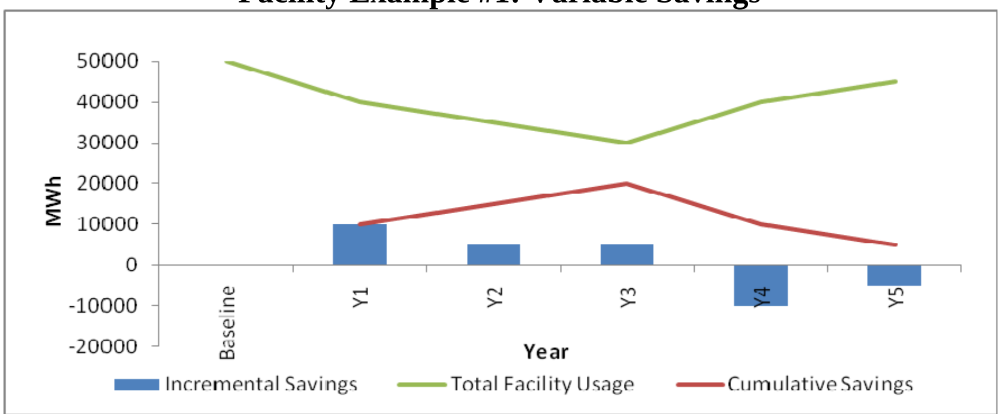
This issue of incremental versus cumulative becomes complex when planning and reporting behavioral measures. Due to uncertainty and lack of research, savings cannot be assumed to persist at a constant level for an assigned useful life. In order for savings to persist, end users are likely to need continuous encouragement to continue their energy saving behavior, with incentives or communications persisting at least long enough for the adjusted behavior to become standard practice (a timeframe which is currently unknown).

Bonneville has examined and tested several methods to planning and reporting the energy savings for behavioral programs:

1. **One year measure life.** If end users must receive an incentive every year, or else savings will disappear, a one year measure life would seem appropriate. In this instance, incremental savings would need to be reported and then removed each year. The next year, if the same savings persist, the savings would be re-booked to the database, resulting in a persistent level of savings for that measure. The issue for our region is that because annual reported savings are incremental to the previous year, there needs to be a clear delineation between cumulative and incremental savings. In a utility paradigm where both cumulative and incremental savings are reported to the regulatory or governing body, this may not pose a problem.

The following chart and subsequent table show an example of a facility that starts with a baseline energy usage of 50,000 megawatt hours (MWh), exhibiting a drop in energy usage from years 1 to 3, and then a rise in total usage. If an organization decided to use a one-year measure life, then savings reported in each year is represented by the red line, cumulative savings, which is estimated from the baseline in each year. This example shows cumulative savings of 50,000 MWh in year 5. The organization would need to be careful to ensure that savings over time (from years 1 to 5) were never summed, which in this example would create a total of 60,000 MWh**;** a figure not shown below because it would be an incorrect calculation leading to an overestimation of the impact of the program. Reporting correct savings is critical for addressing the supply side issues described earlier.

Facility Example #1: Variable Savings



		MWh					
5 Year Measure Life	Baseline	Y1	Y2	Y3	Y4	Y5	TOTAL
Annual Energy Usage (MWh)	50,000	40,000	35,000	30,000	40,000	45,000	
Cumulative Savings (from Baseline)		10,000	15,000	20,000	10,000	5,000	**5000**
Incremental Savings (from previous year)		10,000	5,000	5,000	(10,000)	(5,000)	**5000**

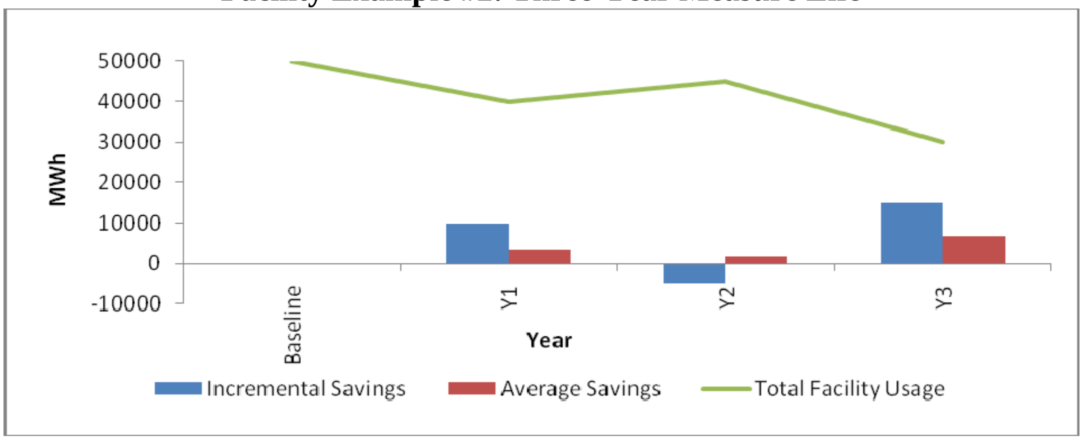
For Bonneville, where management and the Council expect incremental savings reported annually and our savings database are not structured to incorporate short term measure lives, this solution was determined to be too difficult. This is particularly true because Bonneville's annual savings targets developed by the Northwest Power and Conservation Council do not include savings with one-year measure lives (e.g., as noted above, industrial process measures are assumed to have a 10-year measure life). Therefore, if a program were to re-book the same savings every year, future annual savings targets would also have to be adjusted each year to reflect new incremental achievements.

2. **Report first-year savings, true-up incremental savings.** The first alternative Bonneville tested for reporting savings for behavioral measures was to report the full first-year savings and then report only incremental savings. In this paradigm, negative savings will need to be reported if savings decrease from those reported in the first year. Therefore, using the example above, the savings reported would be the blue bars, varying from 10,000 to -10,000 MWh. The sum over time is 5,000 MWh, thereby requiring no change in existing reporting systems. Although mathematically simple, this approach has

several drawbacks, namely that the reporting of negative savings can be confusing for stakeholders and can be problematic for achieving annual targets and managing portfolio costs.

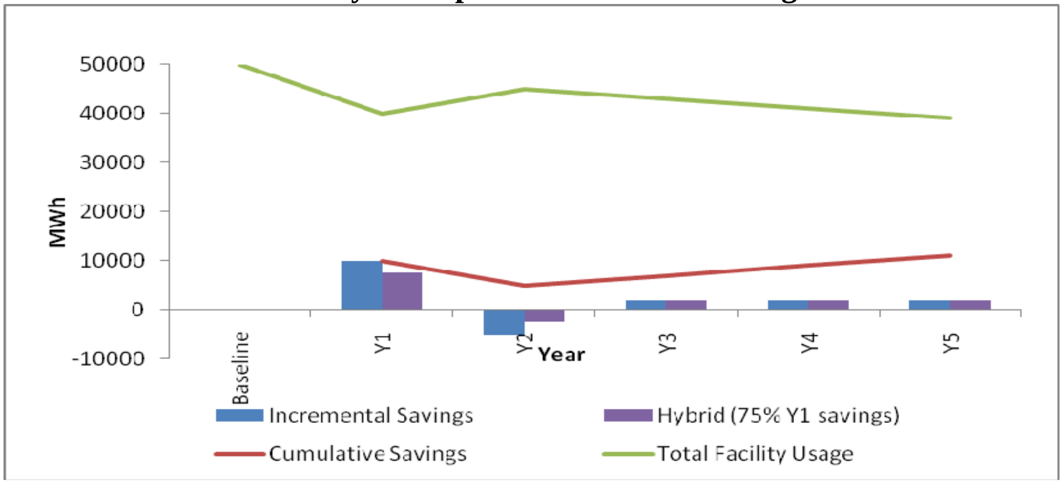
3. **Report average savings**. In an attempt to mitigate the issues associated with booking incremental savings, Bonneville tested an approach of reporting average savings for the duration of the expected measure life through the SIS Light program. This example shows an SIS project that is expected to save increasing amounts over time. Reporting average savings makes incentive payments and savings line up better and also mitigate the requirement of cumbersome contractual requirements. The drawback to this approach is that the savings do not line up with actual load reductions on the system. In addition, this method essentially assumes that the savings will not persist beyond the defined-life, such that the sum of the savings in this example is less than if just incremental savings were reported (that is, in the last year, total usage is 30,000 MWh, but this method accounts for the fact that the lowest point in energy usage is only experienced for a single year).

Facility Example #2: Three-Year Measure Life



4. **Hybrid approach: book partial first-year savings, incremental subsequently.** In an effort to mitigate the issues associated with reporting incremental savings or the average, Bonneville is currently testing another option. In this approach, the organization reports a portion of total savings in the first year, the remaining in the second year, and annual incremental savings each year thereafter. This method allows for a cushion in the first year so that savings are not overbooked, reducing the possibility of reporting negative savings in subsequent years. For the Energy Management pilot, Bonneville has decided to use this approach, where only 75% of first-year energy savings are reported in the first year and incremental savings are subsequently reported, with year 2 receiving "hedge" savings of 25% of year 1. This approach was developed as a middle-road that recognizes that much of the backsliding may occur after the first year of program implementation and therefore, withholding a portion of the savings allows for a cushion in the future. In the example below, the facility backslides by half in year 2, but the hybrid approach avoids the reporting of a negative savings. Yet, the risk of reporting negative savings still exists in subsequent years if a continuous decrease in savings persists.

Facility Example #3: Some Backsliding



Verifying Persistence

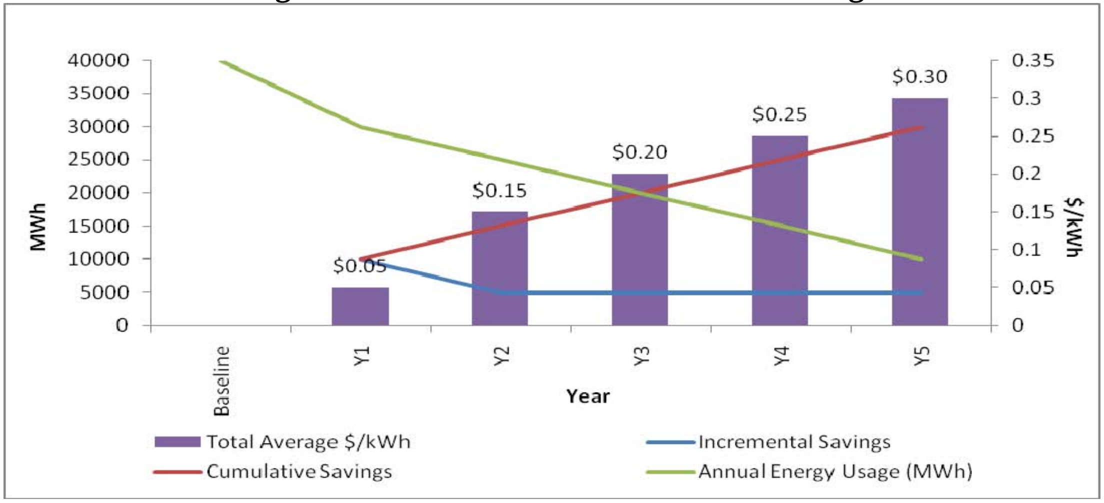
Except for Example #1, all of these examples assume that the implementer knows the energy savings that are experienced in each year. Therefore, one of the risks that programs face when verifying the duration of savings is the need to continuously monitor and measure the impacts. That is, if an end user decides to quit participating in program, removing monitoring and tracking equipment, the program implementer has lost the ability to determine if savings have persisted beyond the last year measured. While in residential programs, billing analysis can be obtained to track energy usage, large industrial facilities are too complex to track baseline and monitor energy savings without participation from the end user. The program implementers must then determine if it can be assumed that savings persisted after the removal of monitoring equipment, or if savings should be removed from reported numbers. This risk not only affects reaching efficiency targets, but can result in portfolio costs with no attributed savings.

Programmatic Challenges

The need to keep in contact with participants and continuously monitor end user energy use presents a new set of programmatic challenges not previously faced with traditional efficiency programs.

If savings are booked entirely in the first year, but payments to the end user for persistence of total achieved savings are paid for annually, portfolio costs (relative to reported savings) to the program implementer will vary widely from the first to subsequent years, resulting in costly programs for years where little or no incremental savings are booked but incentives are paid. The chart below provides an example of a program where consistent incentives are paid annually on cumulative energy savings, but only incremental savings are reported. As seen below, by the end of the payment period, incentives for cumulative savings result in costly incremental savings.

Program Costs for Annual Incremental Savings



To balance these costs, program implementers can adjust incentives to pay only a portion of the annual achieved savings over time. While this helps with program costs, end users may not be as willing to participate in the program with little annual incentive. In addition, in years where negative savings may be reported on an incremental basis, yet incentives to end users are paid on total annual savings, the program implementer would be paying the customer for negative savings booked, skewing portfolio costs and resulting in nonsensical benefit cost ratios.

One way to circumvent this imbalance is to pay the end user for only incremental savings achieved. The problem here is that the end user bases savings on the total savings seen relative to the baseline each year. Payments of only incremental savings may not be enough to ensure that the first year total savings persist over time.

In addition to determining how incentives are to be paid, the next question that needs to be addressed is how long payments should continue. The most cost effective behavioral program would offer incentive payments long enough to ensure persistence of savings even after payments have ceased, but not so long that customers become free riders to the payments. This cannot be answered through energy savings evaluation alone, but would require, at a minimum, process evaluation.

Education and engagement is also a critical piece of a successful behavioral program. It is likely that messages and approaches will need to be continuous and changed over time to keep customer interest and engagement in the program.

Evaluating Savings

There is a broad set of programs that fall under the behavior-based definition. Thorough evaluations will need to be developed for each behavior-based program. These evaluation approaches will vary widely by sector and program design. At this time, Bonneville is evaluating the SIS program and is developing the methodology to evaluate the Industrial Energy Management pilot.

For residential, Bonneville has worked with a group of evaluators in the Northwest to establish approved methods for evaluating residential behavioral-based programs[4]. These

[4] http://www.nwcouncil.org/energy/rtf/meetings/2010/02/Default.htm

methods develop a consistent methodology in sample size requirements, control groups, data cleaning, and the number of years which evaluators should track and measure savings before persistence can be assumed to continue.

Conclusion

This paper focuses on the efforts required to fit behavior-based programs into traditional utility efforts, which are focused on proven cost effectiveness and single time rebates. The issues addressed include uncertainty in estimating measure life, booking and reporting first year savings and the impacts to cost effectiveness and program costs, and verifying persistence. Generally, we have found that fitting behavior-based programs into traditional utility structures requires thoughtful planning and a commitment to significant research strategies to verify the quantity and duration of the savings achieved.

Given the difficulties, additional efforts should be spent to consider how utility frameworks should change to accommodate the increasing role of behavior-based programs. Additional attention should be spent to determine where traditional utility frameworks are hindering effective behavior-based program implementation. For example, this paper discussed savings and payment issues stemming from regional systems, goal setting and reporting that is based on incremental savings. A serious effort should be undertaken to review if these systems can be altered to effectively report savings from behavior-based programs while ensuring to power supply planners that the savings are "real." In addition, traditional approaches to encouraging behaviors through incentive payments should be reviewed to determine if more effective approaches exist for behavior-based programs.