

Measuring Diffusion in a Market Transformation Program

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ABSTRACT

This paper describes an approach to measuring the diffusion of efficiency behavior change. The evaluated BetterBricks program sought to induce multifaceted change among both supply- and demand-side market actors for building design, operation, and maintenance. The challenge: to develop an estimate of energy efficiency behavior adoption – a one-dimensional unobserved (latent) variable constituted by numerous potentially observable behaviors.

We conducted surveys to explore efficiency best practices in detail, including questions to assess the frequency, thoroughness, and scope of activities respondents engaged in. Based on survey responses, we developed estimates of the extent of behavior adoption for clusters of related best practice activities. We identified a cutoff score for the clusters, distinguishing between firms that had *really* versus *partially* engaged in the cluster of best practices. We defined the latent *efficiency adoption* variable based on whether the firm was above or below the cutoff value for each of the clusters of behaviors. The latent variable provided our estimate of the percent of floor space (the market adoption percentage) comprised by firms that had really engaged in the collection of individual best practices. Because we lacked adequate baseline data, we compared efficiency behavior adoption between groups with differing levels of exposure to BetterBricks and found the highest adoption among targeted firms, medium adoption among firms with considerable exposure to BetterBricks resources, and lowest adoption of best practices among firms with minimal or no program exposure.

The paper concludes with a discussion of the method's implications for program planning and implementation, and subsequent research.

Introduction

The Northwest Energy Efficiency Alliance (NEEA) implemented its commercial sector energy efficiency market transformation program BetterBricks from 2005 to 2009. (In 2010, NEEA significantly revised the individual initiatives comprising BetterBricks, maintaining the BetterBricks branding.) According to the *BetterBricks Reference Guide* (NEEA 2009), its mission was to “help drive the demand for and supply of energy-efficient products and services in commercial markets.” The strategy for achieving this was two-pronged: 1) work directly with commercial building owners and managers to change energy-related business practices; and 2) work with trade allies in both new construction and existing building management to help develop their service offerings and enhance their capabilities to deliver energy-efficient high performance buildings. By influencing both the demand and supply sides of the energy efficiency market, BetterBricks hoped to create natural market demand for energy-related best practices while bolstering the market's capability to supply the services that organizations need to achieve those best practices. Rather than providing incentives for designated efficiency equipment, the program promoted deep and sustained changes in the organizational business practices related to facility design, equipment purchase, and facility/equipment operations and maintenance. The targeted business practices comprise best practices in energy efficiency.

BetterBricks continually evolved its identification of efficiency best practices for the targeted sectors (described subsequently), as well as its educational and training (E&T) materials and tools supporting best practices. The BetterBricks website provided additional useful materials and tools from public sources. The program evolved most noticeably during its first three years, as well as continuing throughout the initiative to develop support for end-users and trade allies encountering new challenges stemming from their increasingly deeper adoption of efficiency best practices.

In 2010, at the end of the five-year program cycle, NEEA sought to evaluate the program's success in promoting the adoption of efficiency best practices and the authors conducted the research described in this paper. This research faced three substantial challenges. One, it sought a single estimate of the adoption of a complex set of behaviors. Two, the program staff described the targeted behaviors using concepts that in most cases were not directly observable, but themselves comprised numerous behavioral elements. Three, although throughout the five-year cycle NEEA repeatedly collected what it intended to be baseline data, due to the program's continuing expansion and refinement of its targeted behaviors, the data collected fell short of constituting a baseline for the final evaluation efforts. Thus, we were unable to conduct a comparison of pre/post differences between participants and nonparticipants – the optimal evaluation approach. We addressed this last challenge by conducting a comparison of targeted firms (firms receiving one-on-one assistance from NEEA) – *light touch* firms that accessed NEEA's training and education resources, and its online tools and materials – and nonparticipants that had little or no exposure to BetterBricks.

Program Description

BetterBricks' overall goal was to transform targeted commercial markets so that energy efficiency best practices became standard business practice and providers of energy-efficient products and services were capable of meeting this increased demand. BetterBricks targeted organizations with a *demand* for energy-related services in two *Target Market* initiatives (addressing the first two sectors in the list below) and firms that *supply* energy-related services in two *Cross-Cutting Market* initiatives (the latter two sectors in the list):

- *Hospitals & Healthcare* (H&H) – targeted hospitals and hospital systems having their headquarters in the region served by NEEA.
- *Office Real Estate* (ORE) – targeted firms with a portfolio of commercial real estate holdings in the Pacific Northwest.
- *Design & Construction* (D&C) – targeted firms active in the commercial new construction and renovation markets, principally architects and design engineers, especially in the office real estate and healthcare sectors.
- *Building Operations* (BOPS) – targeted firms supplying building operations services in existing buildings, principally mechanical contractors.

Efficiency programs offered by other program administrators also target both the demand and supply sides of markets with outreach and services. What made BetterBricks unique was the *way* in which it addressed the two sides of the market: separately, but with coordinated overlapping efforts augmented by robust marketing and education and training efforts, and tool development and promulgation. Together, these elements comprised a comprehensive commercial-sector initiative aimed at changing behavior and transforming the healthcare and office real estate sectors, and their service providers, to produce long-term energy efficiency gains.

BetterBricks managers believed that changes – in particular, behaviors within the target and cross-cutting markets – would reduce facilities' energy-related capital and operating costs, align design and construction projects with industry best practices, and likely generate non-energy benefits, such as occupant comfort and productivity.

BetterBricks' strategy for achieving best practices sector-wide was to "work with a few to influence the many." BetterBricks worked intensively with selected organizations in the target markets to illustrate the value of adopting recommended business practices that met the organization's needs, and with selected firms in the cross-cutting markets to increase market capacity to meet demand for best practices by supplying related products and services.

BetterBricks provided a range of services to help participating organizations to change their business culture and practices to embrace and maintain efficiency best practices and reap the associated energy savings over time without continued initiative assistance. The initiative theory posited that as leading organizations in a market achieved sustained efficiency best practices, they would serve as models and stimulate behavior changes in similar organizations through natural market competition and imitation. BetterBricks focused its activities on the medium and large firms that its market research suggested were more influential and more likely to be imitated in the market.

BetterBricks provided *direct-touch* services to the targeted markets through business and technical advisors – contractors to NEEA that worked directly with the selected end-user and trade ally firms to promote efficiency best practices and provide appropriate technical direction and support. Among their responsibilities, technical advisors conducted scoping studies for end-users to identify cost-effective retro commissioning operations and maintenance (O&M) changes and new equipment opportunities, and assisted trade allies with the development of energy efficiency services.

This paper terms recipients of these direct-touch services *participants*. BetterBricks also conducted education and training activities and provided extensive materials and tools through its website. We term nonparticipating firms that described themselves as accessing and being influenced by these BetterBricks activities as *light touch* firms.

Research Methods

Our primary method to measure diffusion from this market transformation initiative consisted of market surveys with representative samples of firms in the four BetterBricks target markets as listed above: H&H, ORE, D&C, and BOPs (McRae et al. 2011). Given the program approach, we conducted surveys with randomly selected medium and large firms in these four target markets. We oversampled all participants in each market (seeking a 100% response rate, if possible) and weighted the final sample based on the percent of target market floor space occupied (H&H), managed (ORE), or served (D&C and BOPs) by the surveyed firms. Thus, the samples represent all firms in the target markets – *participants* (direct-touch firms), *light touch* firms (firms accessing BetterBricks resources and attributing influence to these resources), and *nonparticipants* (little or no awareness of and involvement with BetterBricks). We obtained our population lists from Dunn & Bradstreet.

Survey Design

In fall 2009, NEEA's BetterBricks team wrote the *NEEA BetterBricks Reference Guide* (NEEA 2009) to describe the specific changes BetterBricks sought to achieve in the four markets. **Table 1**, excerpted from the *Reference Guide*, provides the building operations best practices for ORE and H&H building owners and managers. **Table 1** shows that the *Reference Guide* advocates some best practices that: comprise multiple components; imply the use of particular methods; or imply specific scope, depth, or frequency. In addition, the *Reference Guide* uses some terminology or interpretation that is unique to BetterBricks or is not widely used in the market. Thus, the efficiency best practices defined by the *Reference Guide* identify elements that are not, as described, directly observable, but rather are the outcomes of multiple discrete, observable activities.

Table 1. Best Practices in Building Operations for Building Owners and Managers

Best Practice	Evidence
Benchmark energy use	Calculated energy utilization index (EUI), use of ENERGY STAR® <i>Portfolio Manager</i> energy accounting tools
Use building performance services delivered by preferred service contractor(s)	Use of systematic approach and knowledgeable service contractor, outside expertise
Tune-up existing systems and equipment to improve performance (periodic)	Diagnostics, action plans, and follow-through on periodic tune-ups for applicable systems/equipment
Enhance ongoing operations & maintenance (O&M) practices to sustain performance	Review of current practices, adjustments/enhancements to address ongoing operating performance
Invest in operator training/skills development, service contracts	Identification of skills needed, training plans and follow-through for relevant staff
Track and report energy use/costs and savings on a regular basis	Ongoing tracking of energy use/costs and savings, report to key company stakeholders

Source: *BetterBricks Reference Guide*, NEEA 2009.

To understand the *specific* behaviors, decision processes, and business practices the elements in the *Reference Guide* advocated, we interviewed BetterBricks market managers, business advisors, and technical advisors. We explored: the subcomponents comprising each best practice; the desired scope and frequency; the desired tools or methods; and which features would enable evaluators, program managers, NEEA's member utilities, regulators, and others to conclude that an organization had adopted the best practice.

The interviews enabled us to define the program goals and targeted best practices – which (as suggested by the extract presented in **Table 1**) used terms such as *high performance buildings*, *enhanced O&M*, and *fully integrated design* – as sets of discrete, observable, and measureable components so that all could agree on progress toward goals. We developed and refined, through iterations with the BetterBricks market managers, lists of about 60 items for each of the four target markets that captured the intent of the best practice components, tool use, etc. The majority of the items pertained to two or more of the target markets and included such things “conducted benchmarking,” “used benchmarking to set efficiency goals,” and “periodically updated benchmarking.”

We then drafted questions for our market surveys, iterating with each market manager to ensure the phrasing and terms used in the questions would be widely understood by the market, regardless of whether the firms had exposure to BetterBricks. Typically, we used several questions to explore a single topic, as recommended in McRae 2002. We began with a general question, such as whether the firm had a plan for energy efficiency improvements and then followed “yes” responses with more specific questions. **Table 2** illustrates our approach with a line of questions we used to explore benchmarking activities. For simplicity, the table does not include the skip pattern logic.

Table 2. Questions Used to Explore Benchmarking Activities

Benchmarking and Benchmarking-Related Tracking and Reporting Questions	
Please let me know for about what proportion of these buildings you have done the following in the last three years. Please use the categories of <i>None</i> , <i>Less than Half</i> , <i>About Half</i> , <i>More than Half</i> , and <i>Virtually All</i>	
<ul style="list-style-type: none"> • ...Calculated the energy use per square foot (also known as energy intensity, energy utilization index, or EUI) • ...Kept the estimate of energy-use-per-square-foot current by regularly updating the information • ...Obtained an ENERGY STAR® score • ...Kept the ENERGY STAR® score current by regularly updating the information 	
What are you comparing the [energy-use-per-square-foot estimate/ the ENERGY STAR® score] results to? Are you... [Yes, No, Don't Know]	
<ul style="list-style-type: none"> • ...Comparing across buildings you are responsible for? • ...Comparing across buildings in the region? • ...Comparing performance of the same building over time? • ...Comparing building performance to energy use goals? 	
Have you done any of the following with the results? Have you... [Yes, No, Don't Know]	
<ul style="list-style-type: none"> • ...Used results to help in establishing an energy use or savings target? • ...Reported results to building owners' decision-makers 	
Have you trained any of your staff in using ENERGY STAR® <i>Portfolio Manager</i> ? [Yes, No, Don't Know]	

Source: McRae et al. 2011.

We designed the four market surveys to be as similar across the four markets as possible. With that in mind, we created questions in three formats, as illustrated in **Figure 1**.

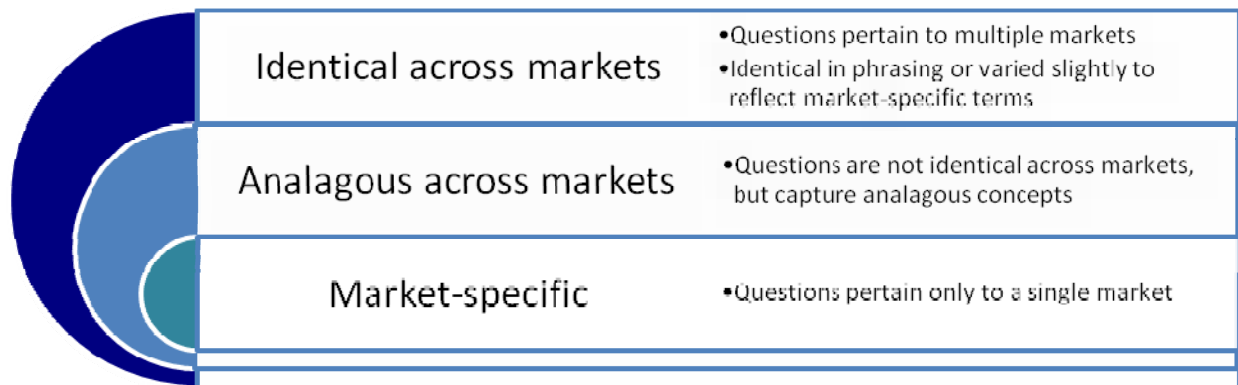


Figure 1. Market Survey Question Types

Survey Analysis and Calculation of Metrics

We derived the estimated adoption of BetterBricks best practices metrics from about 100 detailed questions. Some of the questions sought categorical responses on the proportion of a contact's activity that met the condition posed; the higher proportions earned the most points toward achievement of the metric. Other questions asked whether an activity had occurred. High scores on the metric indicate the contact's firm has engaged in the best practice at least once, but do not preclude the possibility that the firm could conduct the best practice more thoroughly. Thus, high metric adoption scores do not necessarily indicate that

no further market progress can occur. Subsequent studies might want to raise the bar for measuring market transformation through more stringent metric definition.

The research relied on self-reported behaviors. Any of the contacts might have overstated their firm's uptake of the behaviors, particularly if they perceived the behaviors represented "socially desirable" actions. We suspect, but cannot prove based on our method, that nonparticipants, in particular, may have overstated their firms' uptake of the behaviors. This supposition makes sense for both practical and theoretical reasons. On the practical side, nonparticipants' responses suggest greater baseline adoption of the best practices than data regarding commercial facilities' energy efficiency indicate. On the theoretical side, we assume that nonparticipants were less likely than participants to have recently considered many of the concepts posed in the questions. For instance, nonparticipants may have interpreted the practices less stringently than participants, who have received individual BetterBricks coaching.

We coded the response to each yes/no question using a binary 0, 1 code (yes = 1, no/don't know/refused = 0). We coded the response to each categorical, ordinal variable with a scalar that ranged between 0 and 1; we coded as 0 responses indicative of *not at all engaged in the action* and coded as 1 responses indicative of *fully engaged in the action*. We coded responses between these two extremes a proportion reflective of the number of response categories; for example, response categories of *seldom or never*, *less than half*, *about half*, *more than half*, and *virtually all the time* we coded as 0, 0.25, 0.5, 0.75, and 1, respectively.

Table 3 illustrates the algorithms we used to develop metric scores from the responses to the questions in **Table 2**. The first eight rows of the table display the questions that comprise the Benchmarking metric; we weighted each scored (a binary score or a scalar between 0 and 1) response by one-eighth (0.125) to develop a *Benchmarking* score (a scalar between 0 and 1) for the respondent. The last three rows of the table display the three questions that comprise the *Tracking and Reporting* metric; we weighted the first scored question response by one-half and the remaining two scored question responses by one-quarter to develop a Tracking and Reporting score for the respondent. Benchmarking and Tracking and Reporting are two of six best practices (which is why we used a weight for each of one-sixth, or 0.167) within the realm of Building Operations for end-users (H&H and ORE organizations). Finally, Building Operations was one of six H&H business practice areas BetterBricks sought to influence, and thus contributed one-sixth to a sector-wide metric describing the adoption of BetterBricks best practices within the H&H sector. (Building Operations was one of four ORE targeted business practice areas.)

In order to estimate from these metrics the percentage of market square footage that had adopted each best practice, we needed to answer the question, "How much adoption of the complexly defined best practice is 'enough' to count as having adopted the best practice?" After reviewing frequencies of the estimated metrics across the four targeted markets, we concluded that values greater than about two-thirds (specifically, 0.63) provided a clean grouping of the responses. The most *efficiency oriented* respondents bounced above and below the 0.63 cutoff, with very few demonstrating consistent efficiency behavior within and across metrics. At higher cutoff values, few if any respondents qualified as efficiency-oriented across the metrics and at lower cut-off values, most respondents qualified as efficiency-oriented for most of the metrics. Thus, the value of 0.63 seemed to separate the wheat from the chaff. This determination was made independent of considerations as to whether the respondent was a participant, a *light touch* firm, or a nonparticipant.

As noted earlier, high scores do not mean that no further progress is possible. In addition, all of these data are self-reported and may reflect social desirability bias.

Table 3. Algorithms Used to Code Questions on Benchmarking Activities into Metrics

Question	Question Weight	Sub-metric	Sub-metric Weight	Final Metric & Weight
Please let me know for about what proportion of these buildings you have done the following in the last three years:		Bench- marking	0.167	Building Operations 0.167
...Calculated the energy-use-per-square-foot	0.125			
...Obtained an ENERGY STAR® score	0.125			
What are you comparing the results to? Are you...				
...Comparing across buildings you are responsible for?	0.125			
...Comparing across buildings in the region?	0.125			
...Comparing performance of the same building over time?	0.125			
...Comparing building performance to energy use goals?	0.125			
Have you trained any staff in using <i>Portfolio Manager</i> ?	0.125			
Have you...				
...Used the results to help in establishing an energy use or savings target?	0.125			
...Reported results to building owners' decision-makers	0.5	Tracking and Reporting	0.167	
...Kept the estimate of energy-use-per-square-foot current by regularly updating the information	0.25			
...Kept the ENERGY STAR® score current	0.25			

Source: McRae et al. 2011.

Research Findings

In this section, we describe the results of our research following the process outlined above. We sought to detect differences between *participants*, *light touch firms*, and *nonparticipants* in the adoption of efficiency best practices, as evidenced by the market progress indicators (MPIs) or metrics we developed from the survey questions.

Table 4 provides the MPIs by proportion of square footage in the Hospital & Healthcare market adoption of efficiency best practices within two of six targeted practice areas: *Building Operations* and *Integrated Design* (ID). Note that we asked all H&H contacts if they were aware of “the architectural design process called integrated design;” we asked only contacts whose organizations had engaged in new construction or major renovation in the last three years the remaining ID questions.

Table 4. H&H Market Progress Indicators (MPI) in Two of Six Areas

MPI	Proportion of Market Evidencing MPI			
	Total Market (n=35)	Participants (n=22)	Light Touch (n=5)	Nonparticipants (n=8)
Building Operations	70%	95%	75%	33%
...Benchmarking	45%	80%	50%	10%
...Tracking and Reporting	60%	95%	50%	45%
...Energy Performance Targets	70%	85%	90%	35%
...EE Plan	75%	70%	90%	55%
...EE Study	65%	80%	75%	45%
...EE Tune-Up	85%	100%	100%	45%
Design Practices	60%	65%	85%	20%
...ID Awareness	60%	70%	75%	35%
...ID Modeling	50%	80%	60%	10%
...ID Activities	75%	70%	90%	55%
...ID Features	75%	95%	85%	35%

Source: McRae et al. 2011.

As noted, **Table 4** provides our findings for two of six H&H business practice areas. Using the methods described previously, we estimated a value for the latent variable “overall market adoption of efficiency best practices” for each market (and submarket as defined by participant status)

Table 5 summarizes our findings across the four target markets and indicates the proportion of square footage of each market that has adopted the BetterBricks best practices. Note that the sample sizes vary for each market and submarket. We had a low response rate to our BOPs survey and no nonparticipating firms identified themselves as having accessed and been influenced by BetterBricks resources (that is, we surveyed no *light touch* firms).

Table 5. Proportions of Target Market Square Footage that Evidenced Adoption of Efficiency Best Practices

Market	Proportion of Market Evidencing MPI			
	Total Market	Participants	Light Touch	Nonparticipants
H&H (n=35)	40%	50%	50%	20%
ORE (n=41)	70%	85%	90%	45%
D&C (n=43)	45%	100%	49%	0%
BOPS (n=15)	45%	85%	NA	30%

Source: McRae et al. 2011.

Table 5 illustrates that the firms receiving extensive BetterBricks services evidence the greatest adoption of BetterBricks-promoted best efficiency practices. Firms with which BetterBricks did not work closely, yet which had been “touched” by BetterBricks through its education and training activities, its website, and its tools and products, evidenced greater adoption of best practices than firms that had not been touched (nonparticipants). We also found evidence in support of our assumption that larger firms would evidence greater adoption of the best practices than the smaller firms, findings we do not include in this paper.

While we lacked baseline information suitable for a comparison with our post-program findings about the dispersion of MPIs across the participants, our findings are consistent with our assumptions of program influence: the greater a firm’s access to BetterBricks’ resources, the greater the adoption of efficiency best practices. The current findings will now serve as baseline data for subsequent research on BetterBricks’ effectiveness and a further test of the validity of our methods.

Implications of the Research

Our methodology provides benefits, not just by yielding final estimates of market progress indicators, but by assisting the program team to make operational multi-dimensional concepts of the change they hope to induce in the market place, concepts that otherwise can be interpreted in a multitude of ways. Our methodology improves communication, develops standardization, and measures results. These methods also provide a framework for subsequent research useful for improving and targeting the initiative in the next program cycle.

The first major benefit of our method is communication. By discussing the terminology and getting into details about what the terminology means, the discussion supporting survey development clears up potential miscommunications. Program staff and contractors must consider what terminology participants use and be able to adapt to what is being used in the field. Once this communication is established, it can be built on to further refine and develop a consistent terminology with specific definitions, so that all parties (staff, contractors, participants, evaluators, management, and stakeholders) have a common understanding of the concepts promulgated by the program.

Once the terminology and the criteria for *presence* or *absence* of a behavior are agreed upon, when a participant adopts or ceases an efficiency best practice, the change will be apparent. All parties will be able to come to the same conclusion about the progress of the participant and about the diffusion of the targeted behaviors across markets. NEEA has confirmed that firms taking (or receiving) differing access to BetterBricks resources evidence differing rates of adoption of efficiency behaviors; NEEA now has the tools in place to test its theories about the role of market leaders in influencing the adoption of efficiency behaviors.

The benefits go beyond the ability to monitor participant and market-wide progress. The methodology also improves program planning. Communication is improved, as planners can discuss changes as discrete steps. The ability to track changes allows planners to see what behaviors have not diffused across the market. The BetterBricks team has already begun to reap some of these benefits. NEEA used the study results as the team engaged in planning the next cycle of program activities and team members reported to the evaluators that they found the definition of the MPIs brought clarity to their thinking about the market changes they seek.

In the short term, the study findings illustrate the presence of bottlenecks – clusters of behavior, market sectors, and firm types with lower adoption of the efficiency best practices. In the long run, the methodology can support statistical modeling to identify key levers that can be used to more effectively transform markets. For example, are there key best practices whose adoption tends to be associated with greater adoption of all or most other best practices? How influential is the promotion of case studies of

market leaders in the adoption of best practices, or attendance at training events, or the use of specific BetterBricks tools and products?

Conclusion

This paper demonstrates an approach to measuring diffusion in a market transformation program. Ideally, we would have used a participant/nonparticipant pre/post research design, but due to rapid program evolution, the various baseline studies conducted by NEEA became obsolete and not appropriate for the final assessment of program influence in the market at the end of the initiative. Consequently, we pursued the next best approach.

In this study, we worked from randomly selected samples from the population listings for the four markets, where the participants were known to us, and we asked all surveyed contacts an extensive list of questions exploring their adoption of efficiency best practices. We also asked surveyed contacts to describe their exposure to BetterBricks resources and the influence of BetterBricks on their efficiency practices. From the survey responses, we developed metrics to describe the extent to which the respondent firm had adopted clusters of related energy efficiency behaviors. Finally, we estimated the proportion of the square footage of each end-user market and market square footage served by each group of suppliers that had adopted most (defined as about two-thirds) of the targeted energy efficiency behaviors comprising each cluster of behaviors. (Note that high metric adoption scores do not necessarily indicate that no further behavioral efficiency gains can occur.)

Across all four targeted markets, we found evidence that adoption of energy efficiency best practices increased as exposure to and involvement with BetterBricks increased.

To follow our approach, first make a comprehensive list of behaviors that you want to evaluate. Break down complicated behaviors into specific actions that will determine if the behavior is present. Use this information to create objective questions, using scales that are easy to interpret (*yes/no, all/some/none of the time*). If you find the terminology in the market differs from the program's definitions, use terms consistent with market usage. The ultimate goal is to have more stringent metric definitions that can be reliably assessed.

The responses to the questions and metric estimates resulting from this process can show progress on the participant and market levels. Further, with enough data and resources, it is possible to apply factor analysis techniques to gain detailed estimates of the drivers of efficiency behavior adoption. Such an analysis will be easiest if it has been planned for and designed into the program implementation/ evaluation process. This methodology also invites exploration of other research questions, such as the effects of social desirability bias, maintenance of adopted efficiency behaviors, and whether firms adopting efficiency behaviors continue to deepen them and reap increased savings over time.

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