

# Balfour Beatty Energy Solutions

## The Three-Legged Stool Strategy: Optimizing Energy Savings



*rethinking energy*<sup>SM</sup>

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### Delivering a More Effective Model for Energy Conservation

Residential development owners and property managers have long sought ways to cut energy expenses and implement green solutions, ideally with the participation and interest of residents themselves. The team at Balfour Beatty Energy Solutions, LLC (Balfour Beatty Energy) has studied this problem for years and implemented numerous cost-saving, sustainable programs for organizations representing a variety of residential property types across the country. The bottom line, we've found, is tied not just to the homes themselves but also to the behavior of residents. Our innovative "three-legged" strategy addresses technology, behavior and boundaries, where boundaries are social and policy norms that define the energy use context (in other words, boundaries keep us "in-bounds"). This tool provides owners and managers the opportunity to invest in energy upgrades with reduced financial risks. Meanwhile, residents can lower energy costs and all parties are able to realize the benefits of environmentally friendly solutions.

### Green Homes Are Just the Beginning

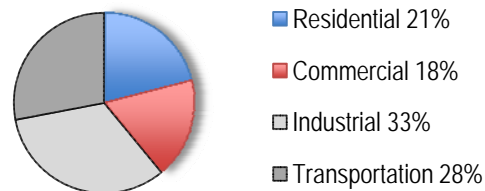
Green development and efficiency improvements for existing homes offer improved market valuation and reduced natural resource consumption. Since the U.S. residential sector consumes 21% of energy annually, these techniques are important.<sup>1</sup> Consider, however, that approximately half of the emissions created from homes depend upon the choices made by people within them. In fact, energy savings from green homes are just the beginning. A review of 38 feedback studies, carried out over a period of 25 years, shows resident behavior alone can reduce consumption by 5 - 20%.<sup>2</sup>

Most green retrofits are done to increase long-term investment value and sustainability. By leveraging attributes found in widely adopted programs such as: Leadership in Energy and Environmental Design for Homes (LEED-H) through the U.S. Green Building Council, ANSI's National Green Building Standard, adopted by the National Association of Home Builders, or Energy Star through the Department of Energy, property appraisals will benefit. These programs offer guiding principles and provide a

source of independent validation for the built environment. Improved design and physical attributes, however, represent only the "technology" of the homes themselves.

Technology is one of three attributes needed to maximize home energy conservation. Occupant behavior and boundaries (both social and regulatory) also have a considerable impact on emissions reduction. We have been unable to locate studies that incorporate technology, behavior and boundaries simultaneously, because although there is significant focus on energy efficiency and green building technologies, there are only a handful of researchers investigating resident behavior as it relates to energy conservation.

### Energy Consumption (EIA 2008)



While many sustainability programs, utility providers and homeowners obtain training about energy conservation, social psychologists have proven that there is zero correlation between the education of adults and a *sustained* behavior change.<sup>3</sup> In other words, educating residents will have little, if any, effect unless those residents have a meaningful reason to change their behavior. But if education won't help, what will?

For decades, marketers have leveraged the power of social modeling, incentives and proven behavior change techniques for all types of products from mobile phones to McDonald's Big Macs.

Unfortunately, the most common technique to date for energy conservation has been the use of education and altruism—both of which are proven ineffective for creating significant behavior change. For example, in one study involving the reuse of towels in a hotel room,

guests were 33% more responsive when the placard discussing reuse focused on what others in the same room had done versus a message with focus on saving the environment.<sup>4</sup>

Our own informal research on more than 70,000 homes and study of social psychology techniques has led us to a similar conclusion and the creation of the “Three-Legged Stool Strategy” supported by technology, behavior and boundaries. Incorporating all three of these attributes is critical for maximizing energy conservation. There are many reasons to focus on significant reductions in energy consumption.

- After food, mortgage payments and healthcare, energy is likely the largest monthly expense for homeowners.
- Energy rate cost increases are expected to continue with the new federal regulation on U.S. power plants, due to the EPA’s declaration in December 2009 that greenhouse gases produced by burning inexpensive coal and oil are a danger to public health.<sup>5</sup> (Current rates increase an average of 7% annually—significantly higher than inflation.)
- Risks associated with resident behavior choices can dissuade Energy Service Companies (ESCOs) from offering Energy Savings Performance Contracts (ESPCs) to neighborhoods because an accurate payback analysis is difficult to predict.

### If Education Alone Won’t Change Behavior, What Will?

We have managed energy and conservation programs for more than 70,000 homes in communities from New York to Hawaii. Based on empirical observations across 53 military communities living in green homes, we noticed residents were consuming up to 35% above the baseline consumption for their respective home types and far more than their peers living outside the military gates. Perplexed, we began a journey of discovery to find out why. Through our efforts, we learned that technology, behavior and boundaries are *all* necessary to support the Three-Legged Stool

Strategy of change.

These particular communities were Public-Private Partnerships with military residents who had never seen their electric bills while living in government housing. Their Basic Allowance for Housing had a portion to cover utilities, so the payments passed directly from the government to the private community manager. (A similar model is used in other government housing used in municipalities.) Since there was no awareness about or consequences for excessive consumption, there was no financial incentive to conserve.

In October of 2006, the Army’s housing partners began charging residents who consumed more than their allocated baseline and sending refunds to those who came in under it through the Resident Direct Pay Program.<sup>6</sup> With this new regulation in place, community managers believed consumption would decline. Consumption dipped for a short time but significant or sustained conservation did not occur. Why didn’t the residents reduce energy expenses? The community owners and their Army partner then turned to education. Electric bills began to contain information that showed residents their consumption compared to the predetermined baseline. Notices included tips for reducing energy use, and some community managers shared conservation pamphlets with new residents.

Unfortunately, there was still no significant change. At this point, we began researching the psychology of human behavior change and learned that there is no correlation for sustained behavior change as a result of simply educating adults. In other words, don’t waste your money on large educational campaigns for conservation with the hopes of motivating inhabitants into action. A few early adopters will engage, but the majority will have short-lived inspiration. While we thought residents “should” reduce energy use, and agreed there are ethical and social reasons for conservation, the proven social marketing techniques found in books like **Made to Stick**<sup>7</sup> by Chip and Dan Heath and **The Tipping Point**<sup>8</sup> by Malcolm Gladwell are far more effective methods to accelerate the adoption of change.

Turning back to the privatized military community case study, we explored possible explanations. Perhaps the financial incentive wasn’t significant

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enough. After all, the amount was only incremental relative to the entire energy bill. (Overage amounts averaged about the cost of a pizza.) Our research turned to studies on human behavior like Warwick University's UK-based study about why only 19% of consumers who had been offered significant monetary savings through deregulation switched energy service providers. The study shows that there is a threshold of expense that must be met, along with a thorough understanding of relevant benefits, before most people are willing to change.<sup>9</sup>

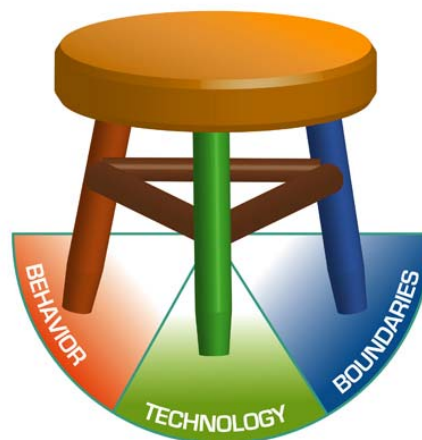
Armed with what we had learned about human behavior and relevant rules, we worked with one of the military communities and partnered with Cornell University to create an educational energy program for residents with a specific focus on lighting. The tips were relevant and concentrated on turning off lights when not in use. The program also communicated the direct relationship between each resident's opportunity for a financial refund and his or her habits of turning off the lights. Simultaneously, in about 2,000 homes, the community manager and its Army partner exchanged incandescent bulbs for more efficient Compact Fluorescent Lightbulbs (CFLs).

The technology improvement from changing the bulbs equated to a 5-7% reduction in energy costs. The New York Public-Private Partnership, however, achieved a sustained energy savings of 12%. While other factors were considered—such as deployment, energy rates and the number of occupied homes—there had been an obvious synergy when all three components were included: energy efficient CFLs (technology), lights being used less (behavior change) and a relevant, shared social expectation by the community (boundaries). We tested this discovery further and our case studies led us to the conclusion that technology, behavior change and boundaries created the greatest synergy in reducing energy consumption. Further, the combined approach created enough savings for residents to notice the decline.

### The Three-Legged Stool Strategy Strategy

Understanding the use of the Three-Legged Stool Strategy will save homeowners, businesses and utilities time and money when implementing energy saving programs. The following graphic provides a simplified illustration of factors that influence the level of energy efficiency and grid dependence within a

home or building. While improvements in one or two of these areas will produce results, the combination of all three creates the greatest opportunity for expense savings and conservation—thus the “Three-Legged Stool Strategy.”



### Technology

Technology is the most common tool used to reduce energy consumption in the built environment. For new structures, energy-saving design methods and products may be used through programs like LEED-H, the National Green Building Standard, and Energy Star. For improving the efficiency of existing dwellings, ESCOs turn first to increasing insulation, sealing ductwork, upgrading HVAC systems, replacing lighting, installing programmable thermostats and making other physical improvements. Technology can include anything within or outside of the home that affects its energy use.

Other forms of technology include distributive energy solutions like solar photovoltaics, solar thermal and smart devices. In military communities, all new homes under the Department of Defense's privatized housing program must be up to Energy Star standards—which includes the use of efficient appliances. More efficient technologies and their incorporation into the built environment is the first step required for maximum energy savings.

### Behavior

As observed in the green-built communities for which we managed utilities, the consumption in energy efficient homes was still 35% above the baseline for corresponding house types. The new efficient homes and appliances were not enough. Studies and

observations revealed behaviors that were inconsistent with conservation from both a housing management and resident perspective, such as:

- Leaving a window open while running the air conditioning so pets could come and go;
- Installing hundreds of programmable thermostats, but not programming them or making residents aware of their advantages;
- Keeping lights on 24/7 for a feeling of added security;
- Setting the hot water heater above 140 degrees (which is unnecessarily scalding hot); and
- Doing a few articles of clothing per load of laundry and/or washing only in hot water.

The *United Nations Environment Program (UNEP) Sustainable Construction and Building Initiative (SBCI)* offers a similar observation about the importance of behavior change: "Significant gains can be made in efforts to reduce energy and improve energy efficiency in buildings with the right mix of appropriate government regulation, greater use of energy saving technologies and behavioral change, that can substantially reduce carbon dioxide (CO<sub>2</sub>) emissions from the building sector which accounts for 30-40% of global energy use."<sup>10</sup> Additionally, the Tyndall Research Center for Climate Change and studies by Doug McKenzie-Mohr (Professor of Social Psychology at St. Thomas University in Canada) confirm a global lack of information on conservation behavior.

### Boundaries

The UNEP SBCI report includes "regulation" as a significant contributor to emissions reduction, but we believe the term "boundaries" describes more accurately the attribute necessary to help change behavior. Boundaries represent the social, economic, public policy and statutory norms within which we operate. Boundaries define our operating environment and are neither intrinsically good nor bad. The standards or rules that keep us "in-bounds" can either encourage or discourage behavior. They can be created or modified to achieve desired behaviors. For example, investment tax credits encourage us to invest in renewable energy assets, while EPA regulations on emissions discourage us from investing in new coal-fired power plants.

Specific to community energy use, boundaries define those rules applicable to homeowners and facility managers. They can be regulatory or social boundaries. Regulatory boundaries limit our behavior through mandatory requirements. For military housing, one regulatory boundary for new development is to comply with Energy Star standards. A social boundary, however, may be the comparison of an individual family's consumption to the usage of families living in similar house plan types. In both cases, people will generally change their behavior to remain within the "boundary" of acceptability.

The effective use of boundaries in energy conservation first requires one to assess the current rules and how they affect behavior. In our military example, homeowners were not billed for consumption nor made aware of community norms prior to the regulatory change by the Army to enact the Resident Direct Pay Program in 2006. Because the boundaries included excessive consumption as an acceptable norm, residents (even in new, green homes) consumed too much energy.

As the boundary changed, residents began receiving bills for excessive consumption. Many of these bills contained a comparison between the individual family's consumption and similar floor plan consumptions. As a result of these boundary changes, it was no longer acceptable within the boundary to consume too much energy—so people's behavior changed.

### Pilot Study to Test Three-Legged Stool Strategy

While several studies have been conducted to test and validate energy savings as a result of in-home display devices that test technology and behavior change, we have created a team that will undertake an enhanced study, incorporating the social boundaries created through dynamic, interactive display devices and targeted coaching. Balfour Beatty Energy is partnering with Balfour Beatty Communities, LLC, Ennovationz, and EnergyHub, Inc. to conduct a study with military residents at Travis Air Force Base in California to maximize energy savings.

Unlike prior studies that focused on real-time data displays, our technology will be interactive and customized to each family's individual consumption-

reduction goals. A personal coach will work with each family to address specific ways to maximize savings, and will relate success to peers in the study. By employing new dynamic technology, focused behavior change techniques and social boundaries, the study is the first of its kind and based upon the Three-Legged Stool Strategy. The study will identify predictable behaviors and recommend strategies that residents can adopt to reduce energy consumption.

By associating a set of coaching and technology services that *predictably and reliably* reduce energy consumption by a given percent, we can then:

- Create an effective energy reduction model, replicable across other communities, that accounts for occupant energy behavior; and
- Develop financial models that will support an ESPC vehicle that will allow communities to improve energy efficiency of older housing stock with no up-front costs to the project company.

### About the Study

In this pilot study, we will isolate energy savings opportunities from behavior alone, constructing our sample of homes to account for both green-built and inefficient homes against a control group of like house types. The initial goal is to identify the resident's specific behaviors that cause high energy use and then apply new boundaries that attempt to change these specific behaviors. We expect that there will be both significant overlap and significant variation in the specific behaviors across homes.

The key goals for behavior from the study will be:

- Identify the specific behaviors that can be applied to other home owners;
- Quantify savings opportunities in an economic model for residential use; and
- Refine the menu of change activators (in-home coaching, custom messaging on the in-home display, email prompts, rewards or other new boundaries assessed).

### In-Home Technology

Technology will be provided by EnergyHub and is Department of Defense security compliant.

No privacy-protected information will be transmitted for this study. Recently awarded recognition by *TIME* magazine, EnergyHub has agreed to donate their technology to this project. Their comprehensive system consists of a touch screen dashboard and a temperature control unit. The dashboard combines the functionality of a home energy display and a programmable, demand-response-capable thermostat in a single interface. EnergyHub sockets and strips provide a full and detailed picture of residents' real-time energy usage, down to the individual appliances.

The EnergyHub system gives residents in our study total control over and awareness of their consumption. They can put their homes to "sleep" with the touch of a button—setting back thermostats and switching off window air conditioners, pool pumps, hot water heaters and unused electronic devices. They can access data and control their homes from the Internet or a mobile phone and compare their usage with their neighbors' or friends'.

Additional devices or processes that may be installed/completed by Ennovationz include:

- CFL bulbs, motion sensors, occupancy sensors.
- Hot water temperature reduction.
- Low-flow showerheads and aerators.

### Behavior Change

Ennovationz was selected as qualified, independent home energy experts to work with residents directly. Founded in 2007 by respected energy expert Martha Amram, Ph.D. in the heart of Silicon Valley, Ennovationz has a team of experts in energy, business and operations who share a passion for reducing energy consumption, lowering carbon footprints and saving homeowners money.

Ennovationz performs home energy audits using skilled residential energy technicians, specialized equipment and powerful software to identify the best and most cost-effective opportunities to save energy and lower utility bills. Their typical customer saves \$500 to \$900 a year and reduces their carbon footprint by 20% after a two-hour home energy audit

by making simple and inexpensive changes. Like Balfour Beatty Energy, Ennovationz is technology agnostic, seeking the best value for homeowners without being locked into any single manufacturer of equipment.

The team will prepare a menu of potential low-cost technologies that can be used to support behavior change. As they perform the audit and coaching session in each home, we will select the appropriate items from this menu and install them during the home visit. All data will flow out of the house to a central server for easy monitoring and analysis. As part of our behavior change motivation, the coaches will offer prizes for energy use reduction and rewards for maintaining that reduction. Ennovationz is pursuing the business arrangements to support this offering.

Ennovationz will be making a minimum of two visits to each house. In the first visit, they will install the energy measurement devices without the countertop display. The data will be streamed out of the home and captured by our servers. Ennovationz will also conduct an energy audit to complete our collection of baseline data. After establishing a two- to three-month baseline, we'll analyze the energy use and identify the areas of potential savings. Data from both benchmarks will be compared to usage data from other homes on the base as well as residences in our database of non-base homes in Northern California. The length of the baseline period will depend on season, resident rotation, patterns in the energy bills and other key factors.

In the second visit to the home, the team will install the in-home energy monitor display, the appropriate technologies and provide information and coaching on energy savings behaviors. We'll also be looking to get a first commitment from the residents and to make them aware of the prizes and rewards for meeting their goals.

### Energy Study Participants

*Balfour Beatty Communities, LLC:* Select houses, provide base access as needed, work through any coordination bottlenecks as we deploy technology, make introduction to relevant community groups and/or schools.

*Ennovationz:* Project lead and coordinator. Analysis of results, both on-going and in final report. On-base installation, coaching and behavior messaging. Integrate technologies and coordinate with EnergyHub. Select final menu of technologies.

*EnergyHub, Inc.:* Provide technologies and stream data from server.

*Boston University:* Provide informal review of on-going project results, provide review on final project results (time donation to project).

*Balfour Beatty Energy Solutions, LLC:* Coordinate team and project pilot locations, assist with technical device selection, coordinate press releases, apply financial models to industry standards and create project summary for consideration of a programmatic rollout.

### Summary

Balfour Beatty Energy believes the Three-Legged Stool Strategy will accelerate adoption of energy conservation by leveraging technology, behavior and boundaries. By identifying and considering the consumption risk related directly to resident behavior, the company hopes to develop an economically feasible financial tool that will mitigate risks of ESPC work in residential communities, assist other homeowners in lowering energy bills and reduce greenhouse gas emissions from the residential sector.



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