

# NUDGING OCCUPANT BEHAVIOR – CULTIVATING POSITIVE ASSOCIATIONS BETWEEN COMFORT, HEALTH, AND BUILDING EFFICIENCY ACTIONS WITH THE DENVER HOUSING AUTHORITY

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## 1. INTRODUCTION

Established in 1938, the Housing Authority of the City and County of Denver (DHA) is one of the nation's most successful housing authorities, providing a variety of livable affordable housing options throughout Denver Colorado. DHA's mission is to serve the residents of Denver by developing, owning, and operating safe, decent, and affordable housing in a manner that promotes thriving communities. DHA manages, owns, and operates a large portfolio of residential, warehouse, office and commercial properties through the City and County of Denver, CO.

One of DHA's strategic goals is to develop and operate sustainable energy efficiency properties through the Denver community. DHA continues to develop and rehab buildings that meet the USGBC rating system and Green Enterprise Communities Standards, include the development of LEED Platinum buildings. In addition to developing and maintaining energy efficient properties, DHA is also focused on engaging with residents to encourage responsible choices around energy use. DHA believes there is significant opportunity for energy and water savings through focusing on the human dimension of energy efficiency.

YR&G has been working with DHA since 2010 supporting sustainable design initiatives for their new construction projects. In 2014, YR&G began working with DHA to design, implement, and perform measurement and verification for a resident education and engagement program focused on energy and water conservation behaviors. The intent is to produce a replicable program that can be implemented across DHA properties.

## KEYWORDS

Multi-family residential, energy efficiency, water efficiency, affordable housing, occupant engagement, behavior, community-based social marketing (CBSM), health, comfort

## 2. BACKGROUND

YR&G, as a company, believes that integrating a human-centric approach to sustainability with the use of data analytics and appropriate technology leads to the most sustainable

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outcomes. We provide technical and strategic sustainability consulting services to organizations, buildings, and communities across the U.S. and internationally. We believe that the most sustainable outcomes occur at the intersection of people and technology, and we use this principle to guide projects to realize their highest potential. Through a combination of modeling, analysis, benchmarking, research, creative visioning, alignment, and education, we facilitate an integrated process and enable results through informed decisions. The challenge in this is convening more expansive skillsets, finding comfort in processes rather than prescriptions, and devising creative ways to ascertain actual outcomes.

This project was unique in that DHA was committed to exploring human engagement as a deliberate component of their overall sustainability strategy, and approached this via a pilot process that would use measurement and verification (M&V) tactics to verify the results. In more conventional green building projects, there is commonly a nod towards occupant engagement via signage or other communication channels that are relatively low-cost and low-effort. However, the potency of these tactics in actually influencing occupant behaviors is often unexamined, and the mechanisms for performing such an analysis present some challenges. Even in the more straight-forward realm of evaluating the efficacy of energy conservation measures (ECMs) that are based on equipment and technologies, it is not common to undertake an M&V program to verify the outcomes. This often seems to stem, in part, from a presumed confidence in the outcomes or a lack of continuity in personnel who can devise, implement, and evaluate ECMs.

By pairing robust technical analysis with human behavior strategies, we hope to demonstrate an approach to occupant engagement that engenders confidence in outcomes, making this arena a more viable opportunity for investing personnel and financial resources. Our work at the Thomas Connable Apartments is intended to be transferable to other properties within the DHA portfolio. This 100-unit high-rise building, located in Denver,

**FIGURE 1.** The Denver Housing Authority's Thomas Connable Building.



CO, consists of 1-bedroom apartments occupied primarily by elderly and disabled residents. The facility is 12 floors, constructed in 1971, and 84,326 square feet.

### 3. SUSTAINABILITY AND COMMUNITY GOALS

The goal of the Thomas Connole Living Green program is to reduce energy and water use while improving the comfort and health of all Thomas Connole residents. The program focuses on resident actions and choices associated with energy and water use within the units. Physical improvements to the units and building are not a focus of this program.

Other DHA goals for the program include:

- Meet resident needs, and focus on delivering benefits to residents alongside energy and water savings
- Meet Energy Performance Contract Phase II (EPCII) requirements, a DHA energy savings program in effect across 12 properties
- Devise strategies that are scalable for the rest of portfolio, meaning strategy should not be too specific to the pilot property and community
- Set it up to have easy persistence, so that DHA can maintain it with limited resources

### 4. PROGRAM DEVELOPMENT AND IMPLEMENTATION

Community-based social marketing (CBSM) was one main framework used to approach the project, as it offers comparatively well-established processes for approaching this type of initiative. We attempted to pair the reductive behavior change strategies that stem from this framework with a strong display of respect, trust, kindness, and a genuine interest in bringing mutually beneficial opportunities to these communities. This type of campaign is not fully reliant on information-intensive strategies (e.g., flyers out the importance of saving energy), but rather endeavors to use behavioral psychology and social marketing strategies that are more mindful of interpersonal communication, social diffusion, and social norms.<sup>1</sup> Measuring outcomes (frequency of actual behaviors and the downstream effect of those behaviors) is the key aspect of understanding program success, compared to a more conventional engagement programs that measure outputs (e.g., number of signs posted, flyers distributed)

There are five steps to CBSM:

1. Select the behaviors you want to modify or promote.
2. Uncover barriers and benefits to the behavior/s, and prioritize them accordingly.
3. Design a program to overcome the barriers to the selected behavior.
4. Pilot the program.
5. Evaluate the program once it is broadly implemented.<sup>2</sup>

Prior to fully establishing a development process for the program, we performed a review of other frameworks, case studies, and resources to draw potential strategies for the DHA program, which are summarized below.

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1. McKenzie-Mohr, Doug. "Promoting Sustainable Behavior: An Introduction to Community-Based Social Marketing." *Journal of Social Issues* 56.3 (2000): 543–554. Print.

2. Ibid.

<p align="center"><b>“Smart Metering for Residential Energy Efficiency: The Use of Community Based Social Marketing for Behavioral Change and Smart Grid Introduction.”</b></p> <p align="center">Anda, Martin, and Justin Temmen. <i>Renewable Energy</i> 67 (2014): 119-127. Print.</p>	
<p><b>Key Takeaways</b></p> <ul style="list-style-type: none"> <li>• Establishes that advanced metering initiatives and CBSM can reduce peak demand and overall energy consumption</li> <li>• Asserts that CBSM techniques can only be effective if site-specific research and planning are undertaken from the outset</li> <li>• Provides a step-by-step overview of using smart meters together with CBSM</li> </ul>	<p><b>Relevance for DHA Approach</b></p> <ul style="list-style-type: none"> <li>• If smart metering is to be used, adopting a two-way dialogue with residents could help increase awareness surrounding energy consumption and foster sustainable behaviors</li> <li>• As noted by the authors, successfully deploying smart meters in for use by low income or otherwise disadvantaged end-users requires particular attention</li> </ul>
<p align="center"><b>Tenant Empowerment Training</b></p> <p align="center">Energy Saving Trust and Housing Corporation. <a href="http://www.cse.org.uk/projects/view/1079">http://www.cse.org.uk/projects/view/1079</a></p>	
<p><b>Key Takeaways</b></p> <ul style="list-style-type: none"> <li>• This toolkit for tenant empowerment training includes: a sample agenda; trainer brief; session outlines for 6 sessions related to energy use, and the financial and environmental impacts, and related actions; training activities; and tenant energy tools.</li> </ul>	<p><b>Relevance for DHA Approach</b></p> <ul style="list-style-type: none"> <li>• The tools and activities were produced by a British agency, and therefore need adaptation for an American audience in general, with Session 4, “Action You Can Take in Your Home” being the most relevant to this project’s objectives.</li> <li>• The “jargon buster” tool is particularly useful, as it supports the notion of relaying information as directly and simply as possible</li> </ul>
<p align="center"><b>“Investigating the Impact Eco-feedback Information Representation Has on Building Occupant Energy Consumption Behavior and Savings.”</b></p> <p align="center">Jain, Rishie K., John E. Taylor, and Patricia J. Culligan. <i>Energy and Buildings</i> 64 (2013): 408-414. Print.</p>	
<p><b>Key Takeaways</b></p> <ul style="list-style-type: none"> <li>• Through a month-long study of 39 individuals, Jain, Taylor and Culligan analyze the effects of eco-feedback systems on occupant behavior.</li> <li>• Their study shows that individuals who received eco-feedback in terms of an environmental externality (e.g. the number of trees needed to offset emissions) were more likely than individuals who received eco-feedback in terms of direct energy units (i.e. kilowatt-hours) to decrease their energy consumption.</li> </ul>	<p><b>Relevance for DHA Approach</b></p> <ul style="list-style-type: none"> <li>• Providing information about energy use to residents in tangible terms (such as through eco-feedback) will likely be more effective in decreasing energy consumption than if abstract terms (kilowatt-hours) are used.</li> </ul>
<p align="center"><b>Oxford Properties Sustainable Intelligence - Operations Guide for Multi-Residential Buildings</b></p> <p align="center"><a href="http://www.oxfordproperties.com/corp/corporate/pdf/Oxford-SI-Operations_Residential.pdf">http://www.oxfordproperties.com/corp/corporate/pdf/Oxford-SI-Operations_Residential.pdf</a></p>	
<ul style="list-style-type: none"> <li>• Oxford Properties is a real estate company that has developed a multi-residential sustainability program concerned with capital, building operations, and tenant engagement.</li> <li>• Tenant engagement includes special events (Earth Hour, Earth Day); incentive programs (awards for the most sustainable property and the individual who has shown outstanding personal commitment); and promoting awareness (informing tenants of environmental initiatives through banners, posters, and newsletters).</li> </ul>	<ul style="list-style-type: none"> <li>• Green Teams could be a helpful way of formalizing collaboration, though should be inclusive of residents to avoid an unsuccessful top-down approach.</li> <li>• Green Team members (and residents in particular) might also participate in the metrics gathering process and progress evaluations as a way of enhancing engagement.</li> </ul>

**Oxford Properties Sustainable Intelligence - Operations Guide  
for Multi-Residential Buildings continued...**

[http://www.oxfordproperties.com/corp/corporate/pdf/Oxford-SI-Operations\\_Residential.pdf](http://www.oxfordproperties.com/corp/corporate/pdf/Oxford-SI-Operations_Residential.pdf)

- The Oxford Green Team responsibilities include defining goals and targets, defining a large-scale annual project, and implementing innovative environmental practices; members include resident managers, operation supervisors, operations managers, and property managers.

## **5. THE SETUP: POSITIONING OURSELVES AS WORTHY COLLABORATORS**

One of the most important aspects of our strategy was to position ourselves as collaborators with the residents and building operators. Most people, including this author, bristle at the suggestion that their behavior is suboptimal. Openness to such a message is particularly unlikely when it comes from an unknown entity that holds no past relationship of trust.

In engagement projects like this, we are explicitly not in the role of teaching people about something they do not know about. Rather, we are partners in helping to uncover and elevate viable sustainable behaviors by facilitating a discovery and decisions-making process, and designing a program that communicates the desired shifts through effective community channels. In our opinion, based on experience, this is a more effective perspective from which to operate.

There were two main populations that we needed to establish a good working relationship with: a) the building management, and b) the residents themselves. The building management staff was more inherently aligned with the overall goal of energy and water reductions because of their direct responsibility for operating costs, though at the outset were cautious about the extent to which residents would embrace the initiative. As the residents increasingly asserted their own interest in the program, the building management's engagement has also increased. Our relationship with the building manager and assistant manager has been centered on exchanging insider information – we share our knowledge of efficiency opportunities and community-based marketing strategies, and they shared their knowledge of the residents, buildings systems, and history of previously deployed strategies.

Establishing shared goals with the residents was not as straightforward, given that we had less insight into their experiences of living in the building, and their priorities around energy and water savings. We planned to have a regular physical presence in the building, to help establish a relationship with the residents and create the social capital we would eventually need to elicit buy in. These sessions helped us get to know the residents as individuals and as a community, and provided a chance for us to hear their priorities for improving life in the building. Prior to holding our initial meetings, we worked to learn communication strategies that would help us to be effective, using Ruby K. Payne's *A Framework for Understanding Poverty* to gain competency in using language that is empowering rather than disempowering in engaging residents around conservation actions.

In our first community meeting with the residents we quickly realized that we needed to frame our program around meeting the needs of the residents, and to be prepared to make adjustments in this direction as we learned more about those need. As we talked about the goals of the program, and how they could help to save energy and water, they told us about



how their homes were too warm in the summer, cold in the winter, had stuffy air, and the HVAC system was not easy to adjust. They were basically telling us “our homes are not very comfortable, can you help us make them more livable?”. After that first meeting we shifted the program focus to include goals around comfort and health and the strong synergies between supporting health, comfort, and energy and water savings.

## 6. DECIDING ON BEHAVIORS TO TARGET: ONE PART ENERGY MODELING, ONE PART JUST ASKING

- Talked to residents to get to know them better and learn about the building
- Conducted surveys
- Performed equipment assessments, historic consumption data analysis, and limited energy modeling
- Brainstormed possible target behaviors
- Collaborated with DHA's energy management staff to select ECMs and strategies

We used a set of initial workshops to establish a baseline understanding of the social context of the building. Walking the building allowed us to collect information about how residents interact with the systems they control (e.g., the HVAC and lighting controls in their units), but more importantly, how they interact with each other and how the physical aspects of the building influence that. Nearly all of the ECMs that we eventually targeted were identified by residents in these early meetings.

**FIGURE 2.** Pledge-signing at an early workshop with residents.

Questions we sought to understand about the social context of the building included:

- How do the social dynamics work?
- Are there residents that “lead”?
- Are there residents that annoy other residents?
- Are there established social structures or committees?
- How do people typically receive information?

### ***Equipment Assessments and Energy Modeling***

To pair our understanding of the social dynamics in the building with the physical asset, YR&G performed a baseline assessment of the building, including a comparison of historic consumption at Thomas Connole to typical usage in Denver, CO. A number of equipment and operation upgrades have been implemented since 2008, substantially reducing consumption. However, though water consumption as of 2013 was 4.5% lower than the typical Denver resident’s consumption, total energy consumption on an energy use intensity basis was still 32.9% higher. This could in part be due to the smaller unit size at Thomas Connole, compared to the average Denver residence.

A large number of energy performance improvements, based on equipment upgrades, were implemented in 2012. The outcomes of these strategies can be seen in comparing the 2013 consumption data to the 2008 and 2009 data.

Improvements included:

- 0.5 GPM bathroom aerators
- 1.5 GPM kitchen sink aerators
- Ballast-assist toilets with bladders
- High efficiency boilers in the central plant
- Make-up air unit fan motor variable frequency drives
- Non-programmable thermostats with high and low-limit set points
- CFL in-unit lighting (13-26 watts)

We sought to uncover potential aspects of the building’s design and function that are most influenced by resident behaviors and were linked to the high energy consumption. Using a building walkthrough and an energy model of a typical unit to evaluate the savings associated with different potential resident actions, we particularly focused on the interaction between passive and active strategies for providing comfort and fresh air. Based on this analysis, the following areas emerged as those most likely to yield energy savings through resident actions:

- Lighting
- Air conditioning
- Plug loads

EnergyPlus, set up with as-built drawings and photos to simulate a typical apartment model, was used to run a few iterations of scenarios to quantify the effect of lighting usage and window operation on overall energy use. From the modeling results, we gained an understanding of the optimal lighting and natural ventilation schemes, and what resident actions would need to be encouraged to exploit those schemes. The simulation helped us to gauge the relative impact

**FIGURE 3.** Summary of Thomas Connole Consumption Data Compared to Denver Averages

## Thomas Connole Energy and Water Use Data

DHA Resident Engagement Program

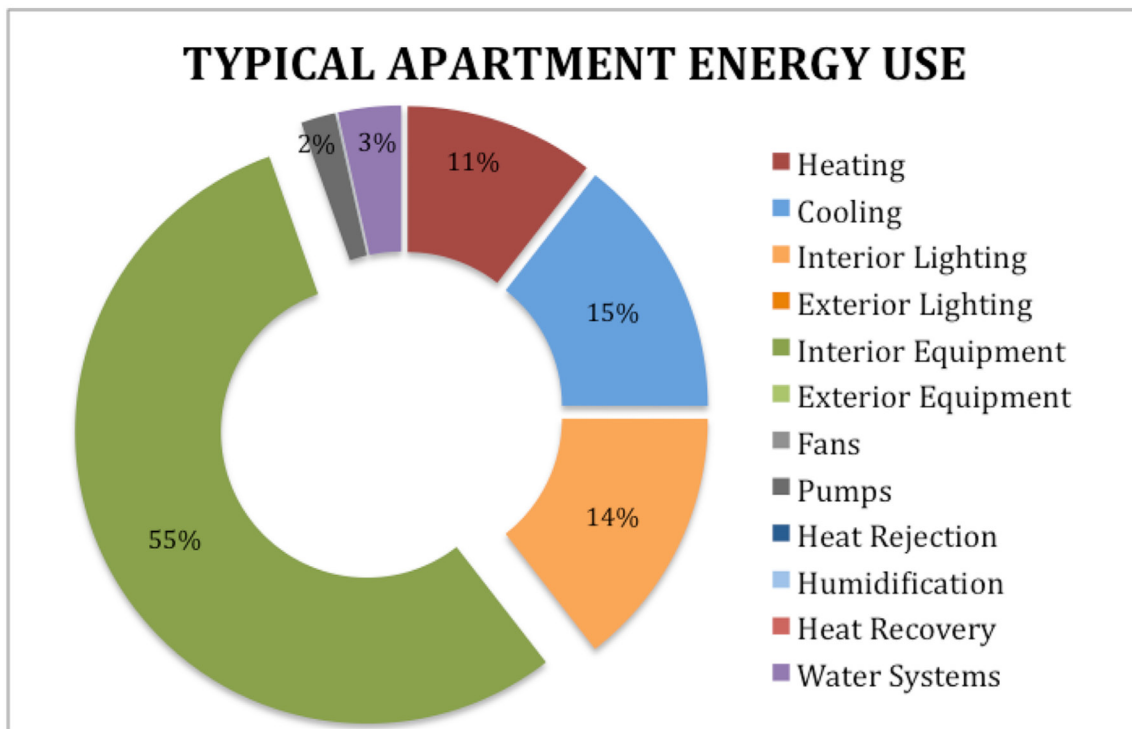
[illegible]

<sup>a</sup> Denver average energy use data based on 2009 EIA data for CO households

\*\* Denver average water data based on Denver Water averaged



**FIGURE 4.** Thomas Connole Typical Unit Energy Consumption Breakdown.

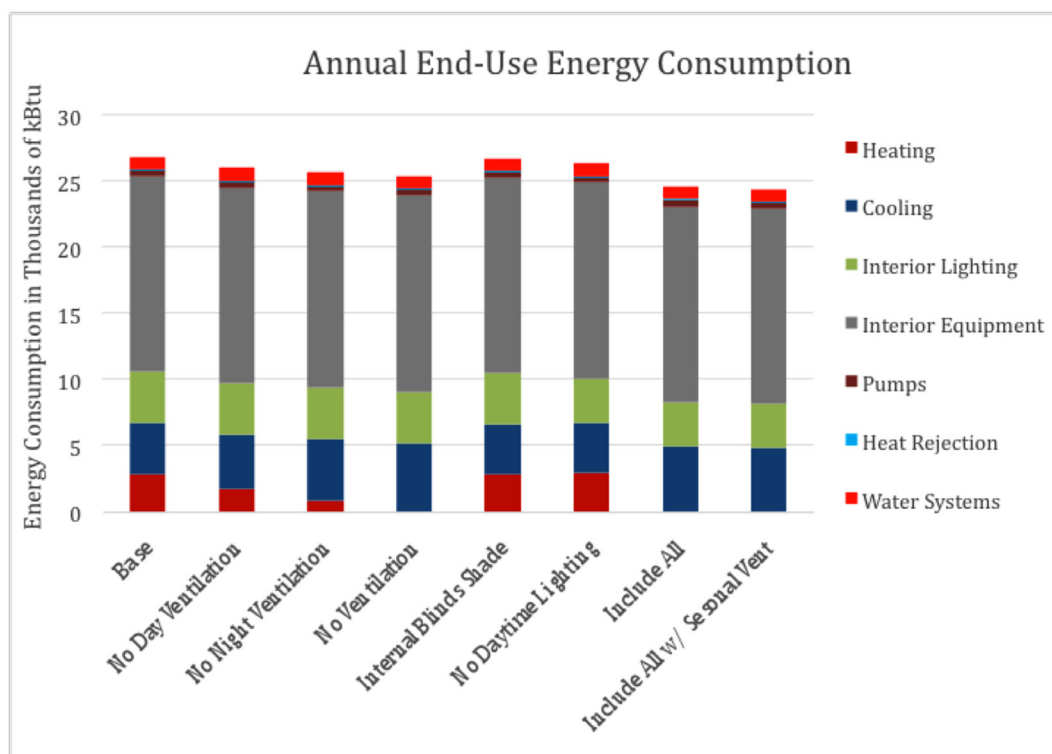


of each type or resident action, providing us with a more nuanced sense of which actions were most important to habituate. If time had allowed, calibrating the model to actual utility bills would have been the preferred starting point, prior to evaluating the effect of shifts in resident actions.

Scenario	% Change from Baseline
Baseline	-
No Daytime Ventilation	3.23% Reduction
No Nighttime Ventilation	4.41% Reduction
No Ventilation	5.49% Reduction
Internal Blinds Shade	0.37% Reduction
No Daytime Lighting	1.82% Reduction
<b>ALL</b>	<b>8.48% Reduction</b>
<b>ALL with Seasonal Ventilation</b>	<b>9.11% Reduction</b>

## 7. NUDGING TACTICS

With the targeted behaviors identified, the next step was to design a program to help nudge residents to take those actions. We worked with the building operators to devise a simple program based around a monthly schedule, and were prepared from the outset to make adjustments as things progressed. We planned to lean first on the use of existing communication channels and the well-established relationships between the residents and the building managers. For each month of the year, we intended to focus only on 1-2 behaviors that were seasonally-based. This

**FIGURE 5.** Typical Unit Energy Modeling Results.**Selected Program Focus**

Targeted End Use	Behavior Nudges
Lighting in Residential Units	<ul style="list-style-type: none"> <li>• Turning Lights off when out of room</li> <li>• Opening blinds to make better use of daylight</li> </ul>
HVAC in Residential Units	<ul style="list-style-type: none"> <li>• Optimized use of operable windows</li> <li>• Thermostat setpoints</li> <li>• Opening/closing blinds to manage passive heat gain</li> <li>• Using fans for improved air circulation</li> </ul>
Plug Loads in Residential Units	<ul style="list-style-type: none"> <li>• Turning off electronics when not in use</li> <li>• Getting rid of unwanted/unneeded electronics</li> </ul>

roll-out schedule is intended to allow time to habituate one new behavior, with residents supporting each other in making the adjustment.

At a high level, we considered engagement strategies that centered on:

- Using relationships and personal contact (engineer, green champions)
- Providing consistent and multimodal messaging
- Aligning with established communication channels
- Eliciting commitments
- Incentivizing engagement

### Deciding on the Details

To drill down to specific strategies we assembled a variety of options for nudging behavior shifts, talked through the options with the building managers and key residents, and decided on the preferred tactic and specific details. It was important to consider which aspects of the program design should be highly tailored to the specific context of this building, versus aspects of the program that are more readily transferable to other buildings and populations.

For example, we considered the following set of options for incentivizing the targeted behaviors.

Incentive Options		
Type	Notes	Preferred/Not Preferred
Raffles	<ul style="list-style-type: none"> <li>• Gift cards have proven to be a popular incentive previously</li> <li>• Smaller denominations with multiple chances to win is preferable</li> <li>• Need to be sure its for a store that people use that's within walking distance</li> </ul>	Highly Preferred
Parties	<ul style="list-style-type: none"> <li>• Coffee hour / pizza party / ice cream</li> <li>• Combine a free food reward with an opportunity to foster a sense of community</li> </ul>	Preferred
Energy-saving Appliance	<ul style="list-style-type: none"> <li>• Tendency for turnover / sale of appliances</li> </ul>	Not Preferred

### Newsletters As a Primary Communication Channel

An explicit goal of the program was for residents to hear about it at least once a week via an active means of communication. During the workshop sessions with residents, we saw excitement and verbal commitments to participate, but we also know that modifying behaviors even among motivated individuals is a slow process. Steady communication helps to habituate the changes we collectively agreed were a good outcome. We also suspect that the regular communications will help uncover residents who are willing to become long-term advocates for the program.

We piggyback on the normal mode of transmitting community news: a monthly printed newsletter. Once per month, we produce a supplemental newsletter specific to the *Thomas Connole Living Green* program.

Using a combination of passive and active engagements, the monthly newsletter cycle has set the rhythm of the program. Each month the newsletter provides reminders about the overall program goals, updates on progress, and requests for support in the rollout of new actions. Concurrently, we provide talking points for the management staff to reinforce and expound upon the key messages in the newsletter.

#### Newsletter Focus Areas by Season

**Fall** – Lighting in units and common spaces

**Winter** – Daylighting and space heaters

**Spring** – Daylighting and plug loads

**Summer** – Air conditioning and natural ventilation

Other aspects of our communications strategy included:

- Using icons to offer a second form of communication, reinforce messages, and engage non-native English speakers
- Using straightforward language (avoiding industry jargon)
- Reporting outcomes in resonant metrics (avoiding kWh and other metrics that do not readily translate to desirable outcomes)
- Improving readability through typeface choice, font size, minimal visual clutter, and colorblind safe colors

**Key Diplomats: The Building Engineer and The Advocate**

The building’s engineer, Allen Gurule, knows what is actually happening in the building, and has frequent and direct contact with residents. Because of this and his strong interest in reducing energy consumption, he has been slated with the role of providing regular reminders to residents about the program and monitoring the uptake of the targeted behaviors.

He acknowledges and provides positive feedback to individuals who are participating in the actions, and is armed with talking points about why we are promoting the targeted behaviors. At a moment’s prompting, he is prepared to explain clearly what the goals of the program are, why they are important, and how the residents’ actions will affect the goals.

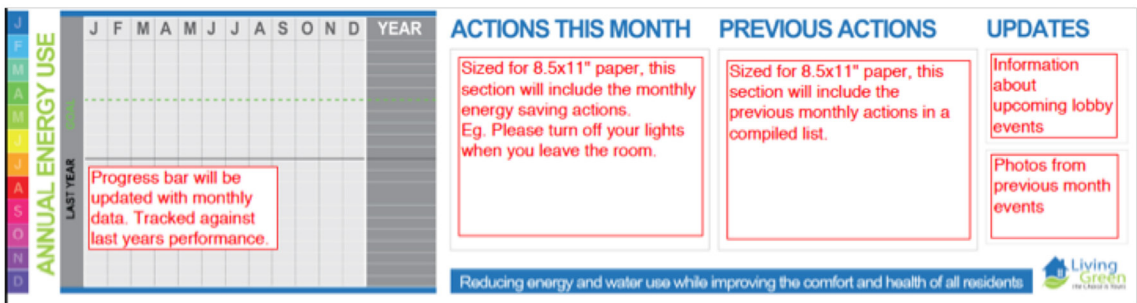
Tsehai Teklehaimanot has the role of Senior Service Coordinator at the building. She advocates for the daily needs of residents, and is instrumental in helping us align our program around those daily needs, and to be effective in communicating that alignment.

**The Intentionally Analog Information Kiosk**

In considering our options for ongoing communications with the residents, it likely would have been less time consuming on our end to focus on electronic materials, but also less effective. Partly because many of the residents do not have computers, but mostly because of the potency of in-person contact, we are intentionally avoiding virtual strategies. All communications are face-to-face, through the building management staff, or through printed media, such as the newsletters.

A bulletin board that can serve as a dashboard of our progress in meeting goals is displayed in the lobby. In other DHA facilities that lack a central gathering point like the lobby as part of their designs, similar engagement programs have to consider other options for spreading community-wide messaging.

**FIGURE 6.** Old School Lobby Bulletin Board to Communicate With Residents.



### ***Being Savvy About What Has Come Before: 74 Degrees of Buy-in***

This engagement campaign was initiated after many other energy conservation strategies were launched in the building, mostly focused on equipment upgrades and restricted control of systems. These approaches were effective in reducing consumption overall, but did trigger some resident actions that were counterproductive. For example, to control heating costs, thermostats in the residences were previously restricted to allow for set points no higher than 72 degrees Fahrenheit in the wintertime. This led to a proliferation of space heaters, creating an awareness by building operators that attempts to control behavior could backfire and lead to more energy consumption.

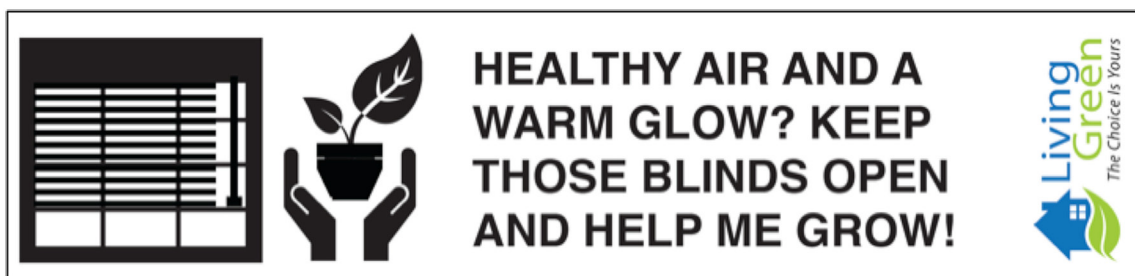
The building management adjusted the thermostat restriction policy and conducted a space heater round up campaign, which mitigated the largest negative effects of the too-ambitious restrictions, but still left some energy savings untapped. As part of our engagement activities, we positioned 74 degrees as a typical set point that was also comfortable, and asked individuals if they would voluntarily adopt it. Over half of the residents stated they would go down to 74 as a personal choice.

### ***Reinforcing Positive Associations***

In part because of the previous energy efficiency upgrades that were more engineering-focused than human comfort-focused, we needed to overcome some negative associations between energy efficiency and austerity. Framing the Living Green program as a way to live comfortably and healthily was resonant with the residents, unsurprisingly. Part of building this association required stepping outside of just the most direct relationships between resident actions, energy, and the environment, and the associated common top-down directives (e.g., turn off your lights, turn down your heat).

Instead, we tried to position the program as something purposeful and community-fostering, with comfort and health at the forefront. This created an outlet for residents to bring their past experience in a way that connects – immigrants with different cultural expectations around consumption, and folks who have lived in poverty and understand the need to minimize utility costs. Food was another avenue to build positive associations. We offered fresh vegetables to residents who took the time to participate in our workshops, and windowsill herbs to those willing to keep their shades open (in support of the plant's health, the resident's health, and the energy savings from the passive lighting and heating).

**FIGURE 7.** Window Sill Herbs Were Offered to Residents with This Message.





### ***Gauging the Stickiness of Messaging***

Though tracking actual frequency of the resident actions we are promoting is challenging and potentially intrusive, we are using a few techniques to understand we have successfully conveyed our objectives, if residents are willing to participate, and if this willingness is translating into action.

Ultimately, the energy data analyzed via our M&V plan will determine the program's effectiveness, but we also need intermediate gauges so we can refine our approach. Three simple surveys have been used thus far, with the main objective of evaluating if residents have internalized program goals, and how likely they are to participate in a given energy conserving action. To understand the actual prevalence of a given behavior, the engineer is provided with sticker sheets to provide feedback to residents – either an acknowledgement of thanks for a behavior that has been adopted, or a reminder for a behavior that is not being displayed. In addition to being a feedback mechanism, it helps us understand uptake rates based on the delta in “reminder” versus “thanks” stickers handed out for a given action.

## **8. MEASURING RESULTS**

With an ECM implemented on a system or piece of equipment, it is relatively easy to verify; the project team can implement the best method for measures and calculating savings while having a concrete implementation date (pre- and post-ECM data). There is precedent for applying M&V strategies to human behaviors, though it involves added complexity in design and deployment. At a holistic basis, we are keen on demonstrating that the engagement program is delivering energy savings. We also would like to understand which resident actions, specifically, are being adopted, and what results are they producing though privacy considerations will preclude us from having detailed information about what actions the residents are actually taking, and how frequently.

Two frameworks influenced our M&V plan:

1. International Performance Measurement and Verification Protocol (IPMVP) Option C – Whole Building Analysis
2. The State & Local Energy Efficiency Action Network's (SEE Action's) Evaluation, Measurement, & Verification of Residential Behavior-based Energy Efficiency Programs: Issues and Recommendations

### ***Measurement Period and Boundary***

Because the facility underwent alterations prior to 2013, whole building performance baseline data will use 2013-2014 utility information. This will be compared against weather-normalized 2015 consumption data. The building's existing utility meters, as well as the electrical meters capable of providing interval data, are the only measurement devices available, which measure energy on a whole facility scale. Presently, there is no way to separate common area and resident unit energy and water use. Due to these constrictions, the boundary to be used for the program and evaluation of savings has been defined as the entire facility.

We considered installing portable data loggers at select resident's electrical panels, but did not pursue this approach due to the following reasons:

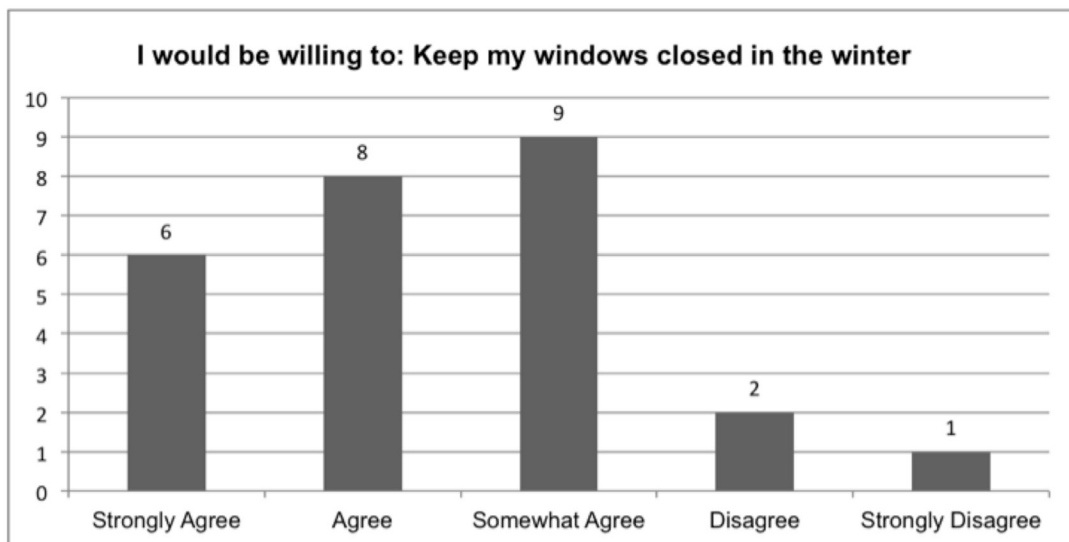
- Limited budget for submetering equipment
- Requirement for resident permission could introduce bias
- Sensitivity around privacy issues
- Even if installed, we lack historical data as the unit level as a point for comparison

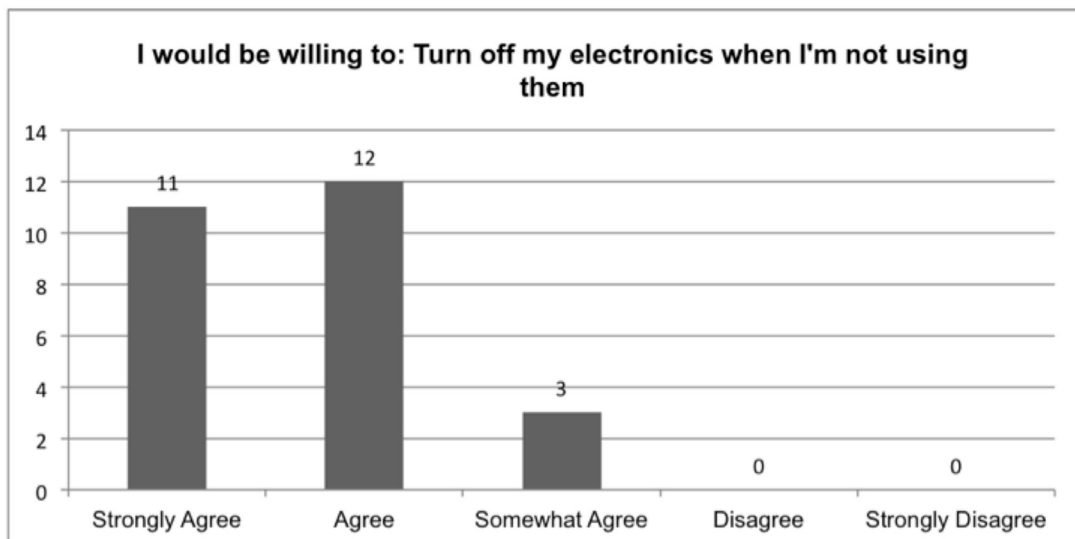
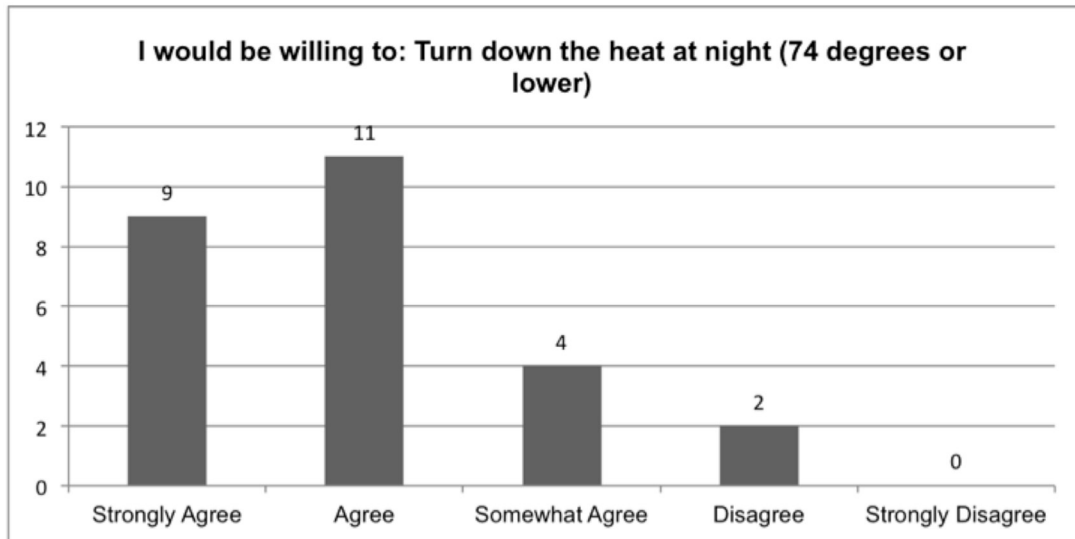
Static factors such as occupancy changes, space changes, alterations to the building's systems or operation, utility costs per unit changes, schedule changes and variations to normal operation that may have an impact on the energy or water consumption will be tracked in order to perform further adjustments to the normalized energy, if necessary.

## 9. RESULTS TO DATE

The behavioral nudges will be deployed throughout 2015, so results in terms of energy savings that can be observed in the utility data is still pending. This significant lag between when initiatives are developed and when the results can be observed is a common challenge in directing resources towards engagement programs, and a primary reason why piloting a program in one setting is advantageous prior to rolling it out to a broader portfolio. However, the energy modeling results shown above, and the M&V strategy that is underway to verify results as they come in, can help a project team gain confidence in a process that is likely to yield the intended outcomes, with an opportunity for course correction prior to the full deployment of the engagement strategies.

One measure of engagement success is the overall participation rate of residents engaging in the program (e.g., through responding to surveys or attending workshops). To-date, 35% of residents have engaged with the program. The below charts show their willingness to participate in some of the actions being promoted by the program.





## 10. LESSONS LEARNED

Given the explicit intent to replicate and expand the program to other DHA facilities, gathering insights about the effectiveness of our approach has been a core objective.

### *Program Design and Initial Workshops*

- There was some confusion around the scope of the program (action/behavior versus structural/building systems). The scope of the program needs to be emphasized early and often.
- Bringing fresh vegetables and flowers to the workshop helped to frame the conversation as including healthy living, and not just energy/water conservation. Residents were very excited to take veggies home at the end of the workshop.
- \$10 supermarket gift cards were a good incentive for residents to participate in the workshop. The \$10 denomination feels like enough of an incentive to get people excited to join. Our approach was to raffle one gift card for every eight workshop attendees, which encouraged residents to ask their friends and neighbors to participate.

- It is important to allow enough time for group activities that involve reporting out, and be diligent about facilitating the conversation and keeping time. Some residents are very vocal and can take up a lot of the allotted time such that extra time needs to be allowed for quieter residents to also be able to contribute.
- Establish a program brand prior to launching communications, and use the brand consistently to avoid confusion.

### ***Nudging Tactics***

- Though commonly used in CBSM campaigns, residents were not very interested in signing pledges, which might be linked to the idea of being policed or monitored. This is important to note for other engagement strategies such as surveys.
- One important decision we made was not to focus on water savings, but instead where there was the most interest and support from the residents. Interestingly, the per capita typical Denver, CO data supported this: these residents were already using less water than typical.

### ***M&V***

- If possible, agitate for best experimental design set up (submeters, clean pre- and post-ECM data, large amounts of historic data for confidence in baseline and the persistence of outcomes).
- Collect and analyze baseline data early, to avoid unanticipated barriers to understanding historic energy consumption

### ***Building Design To Aid Occupant Engagement***

- Points of congregation within building common areas were an important design feature in terms of devising a community-based strategy for delivering feedback and information
- Sub-metering substantially aids the M&V process, and allows operators to both understand the biggest loads that can be influenced by behavior, and home in on the strategies that are actually working
- In-unit equipment loads dominated the overall consumption in units at Thomas Connoles, though it is not easy to influence these through optimized operation or engagement strategies. These loads are best addressed and optimized during the design phase.
- Constraining individuals' ability to control basic comfort parameters regarding temperature and light often backfires, adding energy consumption to plug loads as well as often triggering increased consumption in the base equipment (e.g., space heaters used in the summertime to address over air conditioning). Control designs that balance control with energy efficiency goals should be considered.

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