Energy Efficiency Showcase of Homes

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ABSTRACT

This paper will describe a residential energy efficiency "makeover" program and share the results and lessons learned. Starting in July 2006, several homes in the Chicagoland area underwent comprehensive energy-saving overhauls as part of ComEd's Energy Efficiency Showcase of Homes program. The program provided a rich collection of video clips and photos posted on the Web. Results from the homes with sufficient consumption data confirm the effectiveness of the "whole house", approach but reveal the challenges in verifying savings.

Introduction

As its 10-year rate freeze was about to end and in preparation of a rate increase, ComEd launched a public awareness campaign to inform customers of the impact to them and to highlight the importance of energy efficiency in managing – and even lowering – electric bills. The campaign was branded under the Customer Affordable and Reliable Energy (CARE) banner. A CARE website was created which included several tools to help customers manage their energy bills such as an online energy audit and an online store for energy efficient products. As part of the campaign, ComEd developed the Energy Efficiency Showcase of Homes program which conducted major energy makeovers to a dozen homes across its service territory, and produced narrated "how to" videos of the work that were made available online.

Program Description

The objective for this voluntary program was to select a variety of homes in 12 locations around ComEd's service territory to receive comprehensive energy efficiency makeovers. To date, makeovers have been completed in 11 homes. The scope of work performed in each home was substantial enough to achieve significant energy savings. Six homes completed in 2006 are currently posted online, with detailed videos of the improvements.

Selection Process

For each identified geographical location, a ComEd External Affairs Manager (EAM) coordinated with local officials and community organizations active in housing and energy issues to select seven to 10 candidate dwellings. The EAM then conducted a phone (and sometimes in person) survey to obtain general dwelling features, occupancy characteristics, and energy consuming behaviors. Additionally, this initial customer contact confirmed that there were no conflict of interests, and provided necessary utility account information in order to gather consumption data. An Energy Efficiency Services engineer then put this pool of customers through an energy consumption "filter". The filter looksed for customers who used more than 36 but less than 48 kilowatt-hours a day during base-load months and used more than 1,300 therms of

natural gas annually. These consumption metrics increased the chances for energy saving opportunities in both electric and natural gas usage.

Customers who made it through the filter were put on a short list. The top three customers on the short list were contacted to confirm their continued interest in the process and schedule an energy audit. Customers continued on in the process based on their willingness to participate and the results of the survey. All three short listed customers filled out an application and signed a release form, allowing ComEd to conduct the energy audit and use their homes for demonstration purposes if selectedto receive the improvements.

Next, comprehensive energy audits were conducted at the top three dwellings. The audit process will be described below. Representatives from several ComEd departments including External Affairs, Communications, and Energy Efficiency Services selected the final customer from short list to participate in the program. If for any reason the first customer selected could not participate in the program, the second customer on the prioritized list was selected for participation. In addition, the two customers who were not selected received an energy efficiency consolation gift for up to $500 in value. The gift could go toward an Energy Star refrigerator, an Energy Star window air-conditioner, caulking, insulation, or other measures.

Audit Process

As described above, three homes were selected in each geographical location to receive energy audits. A team consisting of a ComEd energy engineer and a Residential Energy Services Network (RESNET) certified home energy rater conducted the audits to establish an energy performance baseline and to produce a report for each of the participants. The baseline used EPA's Home Energy Rating System (HERS) to evaluate the home's existing energy efficiency characteristics such as level of insulation, air leakage, and heating and cooling equipment efficiencies. The baseline also used energy consumption data and data loggers to establish consumption baselines for appliances and lighting.

The audit included a blower door test, which determines the home's air leakage rates, infrared photography to determine insulation levels, and duct leakage test if applicable. The audits did not include a furnace combustion efficiency test but instead based any replacement recommendations on age of equipment. During the site visit, electric data loggers were deployed to collect electric consumption data on major appliances such as refrigerators. As a result of the audit, a HERS rating value and the home's baseline energy consumption were established. Also, the team produced a report to summarize the site visit's findings and recommend an energy efficiency retrofit package. The package was very comprehensive in nature and included a variety of measures that addressed each home's envelope, mechanical systems, lighting, and appliances. The report also included initial cost estimates, savings calculations, and payback and benefit to cost analysis. The report and energy efficiency package was presented to the ComEd Program Administrator (PA) and then the participant for approval.

Work Scope

The primary goal of this program was to achieve substantial savings through a whole house energy efficiency makeover approach. Therefore, the recommendations generated were comprehensive in nature

and included measures that required capital investment. A budget cap of $20,000 was established per house before any of the homes were chosen. In order to define an economically feasible energy efficiency package, a benefit to cost (BCR) analysis was conducted to test the recommendation package. It was felt that such a metric is more indicative to a homeowner who plans to occupy the home long term than a "payback" metric. Actual contractor proposals were used to calculate the benefit to cost of each measure over the life of the measures. In certain cases, capital-intensive measures with low BCR such as insulation were included because of the overall benefit projected such as the creation of new living space. In general, the individual packages included the following strategies:

- ✓ Ensuring that the home envelope is air-tight and the highest feasible insulation levels are installed. Wall insulation was not included if it was too expensive due to constructability issues or did not provide non-energy saving benefits. Where feasible, spray foam, blown cellulose, and blanket insulation were installed. Insulation was installed where it lacking, in areas including the attic, band joist and bypasses via the basement ceiling perimeter and the attic perimeter. Caulking and weatherstripping also were included in all homes.

- ✓ Installing ultra high efficiency heating and cooling equipment and addressing all distribution issues. This included ultra high efficiency hot water boilers that provided space heating and domestic hot water, and 90+ furnaces and high SEER air-conditioning units. Additional high efficiency equipment included inline tankless domestic water heaters. The work scope included correcting any distribution deficiencies such as lack of return ducts in certain areas, lack of sufficient heating radiators, and relocating supply and return registers to conform to current standards. Such corrections resulted in eliminating the need for electric heat and reduce the "compensation" behavior of raising the thermostat for the entire house when only an isolated area needs heating.

- ✓ Upgrading major appliances to ENERGY STAR appliances. Refrigerator power consumption was metered and consumption used to estimate the savings by replacing to ENERGY STAR units. Refrigerators with potential savings of larger than 60% were replaced.

- ✓ Replacing all incandescent lighting with Compact Fluorescent Light (CFL) bulbs.

Videotaping and Narration for Web Posting

Another goal for the program was to produce a robust portfolio of web based video clips and still images to demonstrate the work and to provide "how to" tools to customers. The intention was to build an extensive library of clips of "before" and "after" images to include a comprehensive list of energy conservation measures in a wide range of dwelling types. These clips also would demonstrate the strategies that address building envelope, mechanical systems, lighting, and appliances. Dwelling examples included bungalows, Victorian homes, split-levels, ranches, and town homes.

The program used in-house Media Production crews to film the video clips and produce the web segments. The program manager narrated the clips to provide the details necessary for these clips to be useful. For each home, an introduction clip was produced along with a segment for each energy

conservation measure that included images of the conditions before the measure, images that show the application of the measure, and images that capture the completed work. In some cases, the installers were incorporated into the video clip to add a conversational element to the videos. A wealth of footage was captured while the measures were applied and in turn included in the posted segments, which added the "how to" details needed to educate the website user.

Program Results

Program evaluations to date have focused on three areas; energy savings, non-energy homeowner benefits, and overall program educational and outreach performance.

Savings Results

Energy savings for the six homes completed in 2006 were calculated using actual pre and post retrofit electric and natural gas consumption data. The savings were then adjusted to weather to account for variances from base-year. Consumption data used included a full year of pre-retrofit data and nine months of actual post-retrofit data. Full year data will be used when available.

Table 1: Electricity and Natural Gas Savings

Dwelling	**Projected Electricity Savings kWh**	**Actual Electricity Savings kWh**	**Projected Natural Gas Savings Therms**	**Actual Natural Gas Savings Therms**
Chicago Bungalow with a Finished Basement	42%	32%	25%	30%
Sprawling Victorian in Rockford	14%	12%	59%	30%
Cottage in Joliet	5%	12%	35%	26%
Historic Victorian in Elgin	13%	11%	31%	38%
New Construction Townhouse in Glenview	12%	22%	7%	-22%
Split Level Home in Waukegan	20%	11%	30%	20%

Initial savings observations and follow up with the homeowners revealed a few findings. The Chicago home occupancy has changed since the makeover. The birth of two grandchildren caused one of the owners to be home with the infants during the week. Such occupancy change is believed to be the reason behind the lower savings. Similar occupancy changes occurred in Waukegan and Glenview where adult children are now at home during weekdays. Pre-retrofit, the homes were not occupied during the weekday. The Glenview results are now being evaluated because of the severity of the differences between projected and actual.

Homeowner Benefits From "Whole" House Approach

This program's non-energy benefits to the participating homeowners can be categorized in two areas; improved comfort and increased property value.

The "whole-house" approach to evaluating the homes energy using systems provides an opportunity to address any heating and cooling related complaints. These complaints are often traced back to deficiencies in equipment sizing or distribution system design. Many of these homes were of a construction vintage where many phases of space and system retrofits occurred over the years. Revamping the mechanical systems as part of the energy efficient makeover corrected these deficiencies and therefore provided properly sized capacities and evenly distributed tempered air or water. Energy savings were enhanced also because discomfort usually results in homeowners trying to compensate by raising the thermostat setting and in turn use more energy than needed. Following are some examples of comfort improvements made:

- ✓ Homes built in the 1930s and before are heated with circulated warm air equipped with central furnaces that used gravity to circulate air. These systems were designed to provide warm air in the center of the house and return it to the furnace through a limited number of registers located around the perimeter of the house. Such configurations result in cold window, exterior wall and door surfaces. Due to the lack of supply air, higher conduction heat transfer films are formed adjacent to these surfaces causing discomfort and again energy waste due to homeowner compensation behaviors such as raising the thermostat or worse yet, using electric heaters. The makeovers switched the locations of supply and return registers and thus greatly improved comfort and increased distribution efficiency.

- ✓ Homes with added second floors are not equipped with any return duct from those added areas. Comfort issues arise in these types of homes because of overheating on the second floor. The makeovers simply provided supply and return ducts to each room on to the second floor and therefore eliminated overheating.

- ✓ Bungalows and similar style homes typically have a sunroom or back porch. These rooms were not meant to be used during all seasons and therefore are not connected to the central heating system. In addition, they typically are not well insulated or tightly air-sealed. The makeovers of two of these homes included newer windows installed by the owners, the under floors were insulated and a separate hot water loop was installed with a dedicated wireless thermostat.

Appraisals of before and after the makeovers show property value increases in the participating homes. Two of the participating homes show significant increases in value because of added living areas as a result of the makeovers. The incremental cost to insulate the attic rafters instead of the attic floor was insignificant compared to the increased value of one of the homes due to the increased living space. Similarly, the incremental cost to including the exterior walls of a back porch in the whole house insulation scope and adding under floor insulation was insignificant compared to the increased the value of one of the homes.

Education and Outreach

The program was intended to be useful to those searching for low cost ways to control their energy bills and to those who are willing to make a significant investment to improve comfort, increase property value, and control long-term energy costs. The program's usefulness was enhanced due to the number of

dwellings included and the variety of the structure types. The virtual tours provided online are comprehensive in nature and applicable to a wide range of measures and dwelling types.

For each of the makeover locations, a media launch event was conducted. At that time, a news release was issued identifying the home, describing the intended scope of improvements, and inviting the media and local officials to get a tour of the home. These events generated local community outreach and energy efficiency awareness. In addition, an expanded outreach program was planned and executed by the company's Communications team which introduced an "Energy Doctor" personality to carry the message of home energy efficiency through these outlets.

The program has succeeded in attracting local and national media attention. Several local networks such as the local FOX, NBC, and CBS stations have featured segments to educate customers on energy efficiency in homes, using the Energy Doctor and the Showcase of Homes. CNN produced a segment on home energy audits and energy conservation by covering a ComEd team as they conducted a comprehensive energy audit and provided recommendations for two home participants. The segments aired on CNN's regular news program and during their Saturday morning "House" program. Major newspapers including the Chicago Tribune and a number of local and community dailies also covered the makeover stories.

The program has provided ComEd with a wealth of consumption data, consumer energy behavior data, and visual images and videos of energy efficiency measures. As the company embarks on its first year of rate based energy efficiency programs, this data will become very useful in designing and implementing future programs. The data will also be used in producing marketing material to help educate customers and promote program participation.

Discussion and Lessons Learned

The program has met its intent and has created a comprehensive portfolio of web based energy efficiency demonstrations. It provided an opportunity to build goodwill within the local communities and the ability to reach these communities through the local media and their public officials. In addition, the program provided ComEd with a wealth of information useful for energy efficiency measure evaluations, consumer energy behaviors, and ultimately future program design. As this program goes through a performance and evaluation phase several areas provide opportunities for improvement and adjustments.

Challenges with the Selection Process

The selection process was applied inconsistently across the 12 geographical locations. As described earlier, the process relied heavily on the External Affairs Manager and local organizations to find candidates for the program. Since these parties were different from one location to the other, different results were achieved. Most of the candidates received from the municipalities are low-income constituents with housing or energy issues. In some cases, these homes were in need of significant non-energy repairs that made them inappropriate. In other cases, areas that were needed for contractor access in order to perform work were very cluttered and would have caused substantial labor cost to relocate.

Savings and Measurement and Verification

As Table 1 shows, energy savings results did not match the audit's projected amounts. Initial observations point to several reasons that need further investigations. It is believed that the lower electricity savings in some cases are due to changes in occupancy patterns where adult children using plug in loads such as televisions, personal computers, and other office equipment occupy the homes during the weekdays. Variance in actual electricity savings from projections are also believed to be due to actual refrigerator usage compared to that published in the Energy Guide. Table 2 shows summary results of monitoring a sample of newly installed refrigerators.

Table 2: Annual Usage of Monitored Sample Refrigerators

Refrigerator	**Monitored Usage Annual Prorate kWh**	**EnergyGuide Annual Usage kWh**
A Maytag MF Series Unit	828	581
Fridgidaire PHSC Series Unit	438	584
Whirlpool GT Series Unit	371	442
GE Adora Series Unit	916	620
GE Profile Series Unit	781	493

The discrepancies between the audits projected natural gas savings and actual savings are presently being investigated. Initial observations point to insufficient consumption data to include an entire heating season, occupancy changes, and the addition of heated space due to the increase insulation levels of areas such as attics and sun porches.

Website Effectiveness

At present, six of the homes are posted on the CARE website. To date, the Showcase of Homes web page has been visited over 4,500 times. Further Market Research is required to determine if the website has been effective in providing useful demonstrations. It is also needed to determine if it has been effective increasing awareness through the Internet.