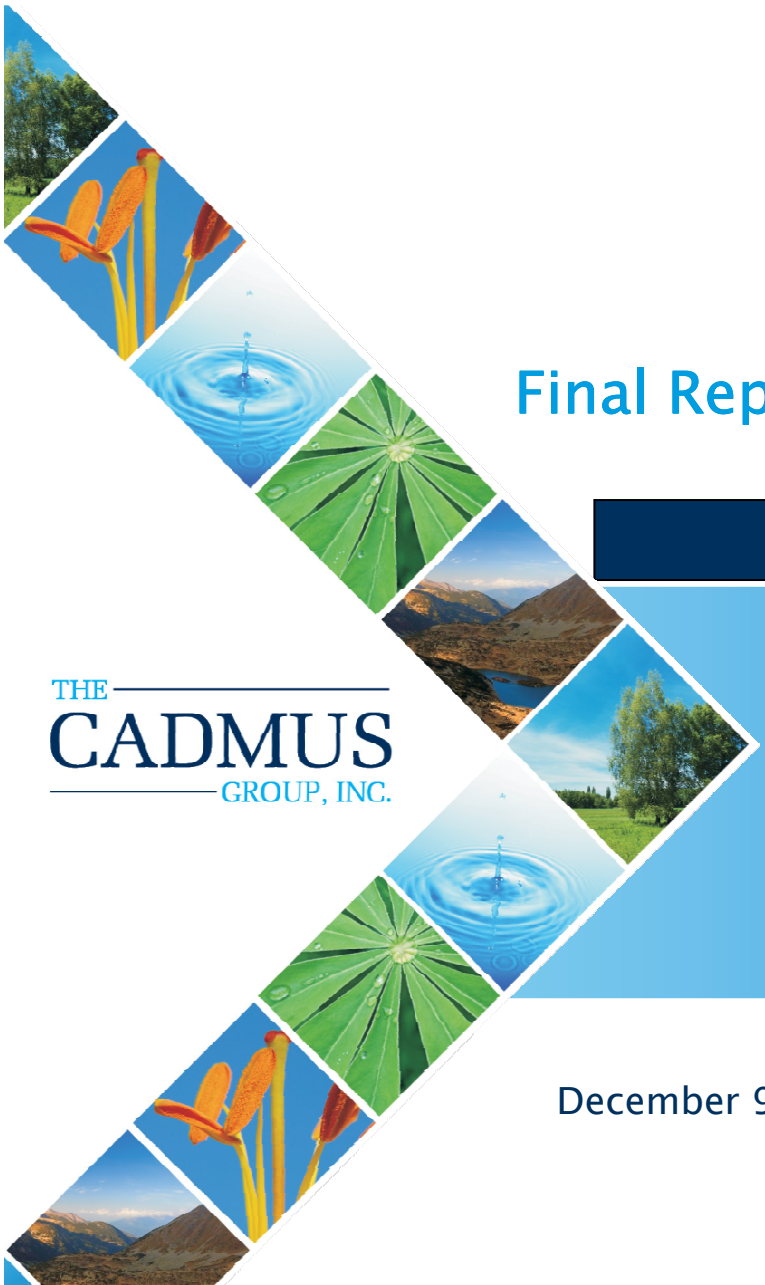


Final Report

Colorado Single Family Weatherization Program Evaluation

THE CADMUS GROUP, INC.

December 9, 2011

Prepared by:
Cheryl Winch
Kate Swayne
Jeana Swedenburg
Danielle Kolp
Katie Gustafson
Charlie Bicknell

The Cadmus Group, Inc.

Table of Contents

1. Executive Summary

Xcel Energy's Colorado Single Family Weatherization Program (COSFW) offers natural gas and electric efficiency measures to low-income households. Depending on need, Xcel Energy may provide any of the following services:

- Natural Gas Measures
  - Furnace efficiency upgrades
  - Wall insulation
  - Ceiling insulation
- Electric Measures
  - Refrigerator replacements
  - Compact fluorescent light bulbs (installation of 16 per home)

For the 2010 program year, Xcel Energy partnered with the Colorado Governor's Energy Office (GEO) to provide the weatherization services. Cadmus considered the GEO staff as implementers and included them in our internal review.

In addition to the above measures, this program provides customer education, which focuses on ways to reduce energy use in the home. Low-income auditors provide educational materials, historical energy usage information, and bill analysis to customers during the weatherization process. Xcel Energy does not claim any energy savings associated with the educational component of this program.

Methodology

Data for this report relied on both secondary and primary data. Primary data came from participant surveys in which Cadmus interviewed individuals that received any of the participating measures from the COSFW. Secondary data, for the benchmarking section, came from multiple program evaluations that included the same, or some of the same, weatherization measures as the COSFW. Additional secondary sources for the technical assumptions analysis are provided in footnotes.

Evaluation Objectives

We planned our evaluation effort for this program around the following tasks:

Task 1. Conduct Project Initiation Meeting and Present Evaluation Plan

Objective: *To provide a forum for program staff to discuss the evaluation's goals, clarify basic research and analyses methods, identify data required from the Company, and finalize the project schedule timeframe.*

Task 2. Internal Review/Development of Logic Model

Objective: *To obtain a description of the internal workings of the program and identify any problematic issues or areas that might impact the data development or analysis of the program.*

Task 3. Primary Research-Participant Surveys
Objective: *To assess program satisfaction, exposure to marketing, market barriers, spillover, and customer input on market transformation.*

Task 5b. Net Savings to Gross Savings Ratio
Objective: *To employ triangulation methods for best estimates of program attribution.*

Task 5c. Technical and Baseline Assumptions Review
Objective: *To outline the technical, methodological, and analytical procedures that will be used to validate and modify the Company's baseline and technical assumptions. Review assumptions; make recommendations for consideration of modifications and improvements as appropriate.*

Task 6: Peer Utility Benchmarking
Objective: *To identify specifics of the COSFW Program offered by peer companies.*

Task 7. Progress Reporting
Objective: *To provide monthly/weekly progress reports to Xcel Energy to communicate the progress and any challenges, including their resolutions.*

Task 8a, 8b, 8c. Draft Report/Executive Summary(s), Final Report, Results Presentation
Objective: *To provide a report of findings including recommendations from the evaluation.*

Task 9: Site Visit Verification
Objective: *To verify that installed measures qualify for the program, were installed correctly, and continue to be installed.*

Findings

Findings for the above mentioned tasks are summarized below.

Task 2: With input from Xcel Energy, Cadmus developed an interview guide and conducted interviews with program staff and implementing agencies. Based on these interviews, we created a process flow diagram (Figure 1 on page 14) and a logic model (Figure 2 on page 15) that document how the program is delivered to customers, as well as the program inputs, outputs, and expected outcomes.

Task 3: With input from Xcel Energy, Cadmus developed interview guides for participating customers. We considered participants as those individuals who received the weatherization services in their home, whether owned or rented. Cadmus engaged Population Research Systems (PRS) to conduct telephone surveys with 381 participants.

Participant satisfaction with the COSFW Program is very high. Nearly all of the participants surveyed (96%) rated their satisfaction with the COSFW Program equipment between 6 and 10 on a scale of 0-10 (with 0 indicating not at all satisfied and 10 indicating completely satisfied). Among survey findings, three-fourths of participating customers believed monthly energy bills had decreased since the weatherization process.

More details and recommendations are provided in the Participant Surveys chapter (Chapter 4).

Task 5b: During the planning phase of the evaluation, Cadmus recommended that Xcel Energy use an assumed NTG value of 1.0 for the COSFW Program, consistent with the Colorado Public Utilities Commission recommendation for low-income programs. This recommendation was adopted by Xcel Energy, and as a result we did not calculate a NTG ratio for this evaluation.

Task 5c: Cadmus conducted an engineering analysis of the COSFW Program Deemed Savings Technical Assumptions (DSTA) section of the 2009/2010 Demand-Side Management Biennial Plan Filing (Filing), provided by program staff.

Cadmus assessed the Xcel Energy technical assumptions to verify which assumptions are supported by current technical references and to identify assumptions for which updated values and techniques may be warranted based on recent studies and findings from our 2011 site visits. Program savings should be developed once Xcel Energy has decided which assumptions to change. The savings in the tables in Chapter 7 illustrate the discrepancies between what Cadmus found in the field and the DSTA deemed savings values, as well as the large savings potentials between various regions.

Task 6: Cadmus completed a benchmarking study to compare the COSFW Program design elements to those of other income-eligible weatherization programs across the United States. Cadmus analyzed several comparison utilities that offer similar programs in Iowa, Massachusetts, New Hampshire, Ohio, and Pennsylvania.

COSFW is comparable to the other programs Cadmus researched for this benchmarking study. All of the programs' weatherization services are delivered through a network of local community action agencies within each utility's service territory. The eligibility requirements for all programs are within the same range. All of the utilities in this benchmarking study offer a broader variety of eligible program measures per home than Xcel Energy; however, the COSFW Program measures funded by Xcel Energy are included in the measures offered by all of the programs compared. Each of the programs Cadmus evaluated also provide energy education to their customers as part of the program, although some utilities offer more extensive energy education than others. These findings are discussed in more detail in the Baseline and Technical Assumptions Analysis (Task 5c) chapter (Chapter 7).

On-site: Cadmus conducted site visit verification at 50 homes across Colorado. Cadmus mapped out the Colorado climate zones (specifically 4, 5, 6, and 7) and superimposed the Xcel Energy participants onto that map in order to draw a random sample of participants stratified by climate zone (see Figure 13 on page 28). Through these site visits, Cadmus determined average model inputs, such as square footage and number of bedrooms for both site-built homes and mobile homes. Detailed findings from this data collection effort are provided in Chapter 6.

Recommendations

The following bullets provide program recommendations on various aspects of COSFW.

- **Continue to use a third-party implementer to run the program**, whether the GEO or a Community Action Program (CAP). Because there are multiple program actors dispersed around the state, use of a third-party implementer has proven to be an effective method of streamlining the program delivery for Xcel Energy.

- **Consider incorporating a cost-effective automated quality assurance process** in the audit software, which would save stakeholder time addressing data discrepancies after the audits have taken place.
- Should Xcel Energy continue to work with the GEO as an implementer, and should the GEO continue to make frequent policy changes, **consider working with the GEO to create a solution for on-the-ground field staff compliance** such as a monthly update document or conference call describing any new changes
- **Consider adding measures to the program** such as hot water measures (showerheads, faucet aerators) and air sealing measures.
- **Consider expanding the insulation options** that qualify for the program. Currently, to participate in the program customers cannot have existing wall insulation, which rules out customers who have very low levels of insulation.
- **Consider including additional AFUE levels for furnaces.** In our interviews with the agencies, they mentioned that the program approved model (of 92 AFUE) sometimes does not fit in the participants' homes, and thus a smaller model might be advised in these cases.
- **Consider whether or not to base the cost-effectiveness of measures on more precise climate zone weather data**. There could be further efficiency gains with heightened collaboration between local, state, and federal agencies.
- **Consider working with implementers** to ensure that they mention Xcel Energy as the program sponsor when they are on-site speaking with customers (if it is important that customers are able to identify Xcel Energy as a program sponsor).
- **Consider working to expand the participation of renters** in the program by working with multifamily buildings and landlord/tenant agreements.
- **Consider conducting some quality control visits.** Presently, some customers have expressed concerns regarding the quality of furnace and insulation installations in particular.
- **Consider collecting the square footage and home type** for electric-only homes, as this information is already being collected for gas and combined homes.
- **For homes with fewer sockets than the maximum CFL bulbs allowed, consider providing a one-for one CFL replacement** and have the contractor invoice per bulb based on the individual home/mobile home socket count. Consider updating assumptions where more current supporting data are available. Cadmus created a comprehensive list in Table 3 of all the assumptions we verified and used to calculate the recommended savings. We did not limit this to the assumptions in the DSTA.
- **Consider home type as a component of savings achieved through gas measures.** Currently, deemed savings are for site-built homes only. Twenty percent of the residences we visited during the verification site visits were mobile homes. The savings achieved though gas measures for site-built homes are up to 68 percent greater than the gas savings achieved for the same measures in mobile homes.

- **Consider climate as a component of savings achieved for insulation and high-efficiency furnace measures.** Currently, Xcel Energy uses a singular value for all program measures in all locations. This is appropriate for refrigerators and CFLs, but may not be the best approach for insulation and furnace measures. The current deemed value is specific to the Denver metro area. Xcel Energy can achieve greater accuracy and savings by using climate-specific deemed savings (see Figure 16).
- **Consider increasing training standards for installers.** Cadmus found that 35 percent of program ceiling insulation did not meet the final requirement of R-38.

Recommendations for the GEO

- **When reviewing audit data, consider downloading only what is rebate eligible.** This could save time reconciling data that do not need to be considered for program purposes.
- **Provide additional training for agencies,** and consider having the GEO spend more time accompanying technicians in the field.

2. Introduction

This report summarizes Cadmus' findings from our evaluation of Xcel Energy's COSFW Program for program year 2010. This program offers natural gas and electric efficiency measures to low-income households.

This chapter describes the evaluation methods and data collection activities we conducted and provides a report overview.

Research Methods

Cadmus conducted data collection activities from February 2 through May 24, 2011. These activities focused on gathering inputs to inform the process and impact evaluations. Our research approach for evaluating the program consisted of the following activities:

- Review of Xcel Energy's program participant tracking database
- Primary data collection via surveys and interviews with the following market actor groups:
  - Program staff (Xcel Energy staff n=7 and implementer staff n=5)
  - Participants (n=381)
- Benchmarking of single family weatherization programs (n=5 comparable states)
- Site visits and verification of weatherization measures (n=50)

Subsequent chapters provide additional details regarding methodologies for each evaluation task.

Report Overview

This report is organized into the following chapters:

- Chapter 3 presents the program description, history, and design.
- Chapter 4 presents the results from the participant surveys.
- Chapter 5 presents the NTG ratio.
- Chapter 6 presents findings from the verification site visits
- Chapter 7 outlines the baseline and technical assumptions analysis.
- Chapter 8 provides benchmarking results for the program.
- An appendix is included with all of the data collection instruments.

3. Program Description

Program History and Design

The COSFW Program officially began in 2009. Prior to 2009, Xcel Energy provided the State of Colorado with funding for a portion of the state weatherization program. In 2010 the COSFW Program achieved its electric participant and savings goals, but, due to an error in the filing, only achieved 50 percent of its gas participant and savings goals. This error was a result of savings goals not being updated when measures were removed from the program. These savings goals were updated for the 2011 program year, however; this report addresses the savings achieved during the 2010 program year.

Process Interviews

This chapter outlines a summary of our findings from program interviews with stakeholders at Xcel Energy and the GEO, the program implementer.

Market Actors/Roles

Cheryl Winch of Cadmus conducted interviews in March 2011 with:

- Kate Warman, the Xcel Energy program manager from 2008 to 2010.
- Jackie Ducharme, the new Xcel Energy program manager as of 2011.
- Stacey Proctor, the weatherization program manager for the GEO.
- Bruce Boerner and Drew Quirk, Xcel Energy energy-efficiency engineers. These two men derived technical assumptions and deemed savings for the Filing.
- Neil Cowan and Jeremy Petersen, Xcel Energy regulatory staff. These two men submit filings, post program changes to stakeholder groups, coordinate quarterly stakeholder meetings, and provide status reports.
- Steve Elliott and Donna Garrett, Arapahoe County Weatherization Division workers. These two people provide home weatherization services, complete the initial home visits, contact funding agencies to verify participant status and to determine their willingness to fund installation of weatherization materials, and install the weatherization upgrades in homes.
- Steve Getz, Northwest Colorado Council of Governments (NWCCOG).
- Chuck Watkins, Mare App and McKenzie Strobach, Veterans Green Jobs.

Overview

The COSFW Program was designed to achieve gas and electric savings targets, as well as to improve the comfort level of low-income qualified homes while reducing the energy bills for these customers. Xcel Energy funds specific weatherization measures—attic and wall insulation, furnace efficiency upgrades, refrigerator replacements, and compact florescent light bulbs (CFLs)—as direct install measures. Through the program, Xcel Energy also provides customer education on ways to save energy in the home, although no energy savings are claimed from the education component of the program.

The program is managed in partnership with the GEO, and funds supplement federal and state weatherization grants. These grants are administered by the GEO and fund eight agencies that deliver services to local residents. The broader state and federal program provides additional measures beyond those funded by Xcel Energy. These additional measures and services are provided to low-income residents who may or may not be customers of Xcel Energy. The additional services and measures include health and safety repairs and upgrades that do not contribute directly to energy savings.

Xcel Energy contracts with the GEO, which then contracts with the following agencies: Northeast Colorado Association of Local Governments; Pueblo County Department of Housing and Human Services; Energy Resource Center; Housing Resources of Western Colorado; NWCCOG; Longs Peak Energy Conservation; Arapahoe County Weatherization Division; Four Corners Office for Resource Efficiency (4CORE)[1]; and Veterans Green Jobs.

Program Design

The program was designed around three best practices as referenced in a 2004 study performed by Quantum Consulting, Inc.,[2] specifically:

- It is most cost-effective to pay incentives based on individual measures;
- To ensure program success, educate customers on all program aspects to find new opportunities for them: contractors are the primary link between customers and energy savings; and,
- Focus on market transformation: market the ability for homeowners to improve the value and comfort of their home.

Program Delivery

To qualify for the program, Xcel Energy customers must provide income documentation indicating that they meet the requirement of 200% of the Federal Poverty Level or below. Customers who apply to the program and are also participating in Colorado's Low-Income Energy Assistance Program (LEAP), or currently receive financial assistance from any of the following programs such as; Temporary Assistance for Needy Families (TANF); Aid to the Needy and Disabled (AND); Old Age Pension (OAP); Supplemental Security Income (SSI) do not need to provide income documentation as these programs also verify income. The state then provides a list of LEAP residents to the ten participating agencies throughout the state that help manage the program within their territory.

Upon receipt of the list of eligible residents, agencies contact those residents by letter or phone to inform them about the weatherization program and to ask if they would like to participate. Residents who do want to participate may be added to a wait list if the agency is at capacity in their region. Eligible residents may be on the wait list from just a couple of weeks to more than six months, depending on the agency capacity. In the meantime, agencies send the list of those who would like to participate to Xcel Energy. Xcel Energy crosschecks the list of residents against their customer records and provides those customers' energy usage data to the agency.

[1] This organization was not included in the evaluation as they do not have any Xcel Energy customers.

[2] Quantum Consulting, Inc. *Best Practice Benchmarking for Energy Efficiency Programs.* 2004.

Once the agency receives the energy usage data, they contact the approved customers (or those on the wait list) to schedule an energy audit. Those on the wait list who are seniors, have disabilities, or have children under the age of five receive priority. Auditors complete an energy audit encompassing checking furnaces, air tightness (blower door test), insulation levels, refrigerators, and energy-efficient lighting options, and also conduct a general health and safety inspection of the home. All auditors use the Department of Energy's (DOE's) audit software tool (NEAT for single family homes and MHEA for manufactured homes), which provides a savings-to-investment ratio. The participating agencies are requires to install measures with a SIR or 1.0 of greater if feasible. The agencies then provide information to the GEO on the actual work completed. (

Based on the audit and resulting work orders, the agency determines whether to use their own staff or if an external measure-specific contractor is required. Agency crews install the light bulbs. The agency weatherization team then performs the work indicated on the auditor's work order. Before leaving the home, the weatherization team talks with customers about what they installed and ways to save energy, and they leave educational materials behind.

If the audit results indicate a problem with the customer's furnace, or if the furnace is a non-efficient model (one that does not meet the replacement criteria of the SIR)), the agency sends a furnace contractor (some agencies do have in-house furnace technicians and in these cases a furnace contractor is not used) to the home. The contractor either fixes the furnace or orders and installs a new one. The same process is followed for refrigerator replacement. If the household has a secondary-use refrigerator, crews will offer to recycle the secondary refrigerator at no charge.

Agencies then enter data from each home into a database maintained by the GEO. The GEO sends invoices to Xcel Energy for the qualifying measures installed in customer's homes.

Upon completing installations in the home, the work is inspected by another team within the agency. The GEO and DOE also inspect some customer homes throughout the year, and audit a number of the agencies' files.

Program Administration

Program Eligibility

LEAP participants are automatically eligible for the program. Those who have not already applied to LEAP must fill out and send in an application with income statements, check stubs, and other materials necessary for identifying eligibility. When a new calendar year begins, customers on the wait list that have not yet participated in the program must reapply for LEAP funding in order to qualify for the program. A customer also qualifies if they are on one of these programs or currently receive financial assistance from any of the following programs; Temporary Assistance for Needy Families (TANF); Aid to the Needy and Disabled (AND); Old Age Pension (OAP); Supplemental Security Income (SSI). The program administrators follow the GEO's eligibility rules.

Tracking Participation

Every auditor has a standard form for each home, where they record all recommendations for repairs and labor. They also use a software system, called Focal Point, which is a Microsoft SharePoint-based system.

Interview respondents identified human error and missing data in the list of potential participants, as well as incorrect manual data entry during the site visits.

Inspections/Verification

The program is subject to agency inspections, as well as inspections from state, and federal personnel who ensure that measures were installed properly. The GEO visits five percent of the homes for each agency per year. Typically, for every five to 10 homes they visit, at least one home has an issue with one or more of the measures installed. The findings can either be a minor or major, but a "go back" to correct the issue is usually required. A minor or major finding depends on how frequently the mistake is repeated or if a major health or safety risk is present.

It became apparent during the interview process that some of the crew members from participating agencies could benefit from more training. Although all crew members attend training, some individuals are limited in their relevant past experience and may need further instruction. A few interviewees also mentioned that they would find it helpful for the implementer to accompany them in the field and provide insightful feedback.

Opportunities for Process Improvement

Another issue that came up several times during the interviews is the extent to which policies are being revised and updated. Agencies find it difficult to comply with new policies that require implementation within 10 days. This is compounded by the fact that some auditors do not have computers to access the updated policies on the SharePoint site, nor do they have the ability to print documents from the site.

Most interviewees believe this issue will be abated to some extent after the GEO is finished accommodating the large list of program updates that were mandated by the DOE in 2010. The GEO data system is also currently under review to determine how it can be improved. Interview respondents stated that the GEO collects a lot of non-essential information, which causes them to spend extra time reconciling the data.

All agencies use a standard GEO form for customer feedback after all the work is completed. While auditors may collect anecdotal feedback, there is only one satisfaction question on the form. Auditors share feedback with their crew that is specific to them, then send the rest of the feedback to the GEO; this information is not shared with Xcel Energy. Xcel Energy does, however, conduct a follow-up survey with a sample of weatherization program participants. This survey includes several questions that are used for verification and quality assurance.

The interests and viewpoints of the various parties involved in the program are sometimes at odds. For example, engineers must document every phase of the home audit in the state system. This adds time to the process and is of little value to the auditor or homeowner. However, this process enables the state to monitor the auditing progress in real time.

According to one viewpoint, rather than auditing all homes to demonstrate program cost-effectiveness, sample audits of generic housing types could be performed. Past experience has shown that this process leads to a nearly identical outcome while saving time and money.

Another viewpoint is that the high number of strict regulations may be leading to fewer measures being provided per home. One example given was that, although rebate-eligible furnaces must be 92 percent AFUE or higher, some homes are not compatible with a furnace of such a high rating. Since some areas have a high number of heating degree days, it may be cost-effective to install a furnace with only a 90 percent AFUE rating.

Another example of various program viewpoints is the difference in standards between Xcel Energy and the DOE. Agencies have found Xcel Energy's minimum R-value for current insulation prohibitive. While in some cases agencies install insulation when the software determines it as a cost-effective measure, funding must be directed from a source other than Xcel Energy.

Differences in measures approved by the various program financers has significantly increased bookkeeping demands. Agencies must review each job uniquely to be certain of which measures will be covered by which parties.

Program Implementation

Advertising

The primary way that participants learn about the program is through the LEAP process. The GEO provides some advertising through the Recharge and now the GEO (www.colorado.gov/energy) Colorado Website, and Xcel Energy sends energy-efficiency education materials to homes through bill inserts. Since auditors do not specifically tell participants about Xcel Energy's sponsorship of the program and the GEO's advertising does not mention Xcel Energy's involvement, most participants are unaware that Xcel Energy sponsors the program.

Communication

Xcel Energy and the GEO meet bi-weekly to discuss updates on the wait list, any new efforts, and any discrepancies that might exist between what Xcel Energy has funded and what was invoiced. The agencies have monthly director's meetings and bi-weekly program manager meetings. Within each agency, client services, technical team issues, and policies are discussed.

Several interviewees revealed that working relationships and communications with the GEO have improved within the past three to five months, where previously, communication challenges were a source of frustration.

Goals

Respondents reported they were mostly confident in their ability to meet their goals in the coming year. The number of measures that have been implemented since 2010 has increased. However, one respondent did report a difficulty meeting changing standards and with the sometimes different standards among various program stakeholders.

Tracking Database Review

Cadmus reviewed Xcel Energy's tracking database *Electric – Gas Combined Sample.xls* in accordance with Xcel Energy's material review protocol. We found that the relevant data fields are contained in the tracking database in order to evaluate project enrollment. Cadmus found that the project completion date was tracked, however the project start date was not. The tracking database notes which program measures have been installed as well as the incentive payment dates. The tracking database could enhance the future evaluability of the program by tracking square footage for electric-only participant homes (gas and combined is already being collected) and home type from the GEO's database.

The tracking database has an *Electric* tab and a *Gas* tab. The database tracks gas customers on one tab and electric customers on another tab. The measures being tracked on the gas tab are: ceiling insulation, wall insulation, and furnace replacement. The measures being tracked on the electric table are: ceiling insulation, wall insulation, refrigerator replacement, and CFLs.

Cadmus used the program database to determine the number of actual program participants by measure for 2010. Using a combined sample with duplicates removed, Cadmus determined the number of program participants based on specific measures associated with each debtor number. The resulting participant measure counts are provided in Table 1 below.

Table 1. Incentives for Efficiency Measures

Efficiency Measure	Incentive to Agency	Expected Participants 2010	Actual Participants 2010
Ceiling Insulation (R-11 to R-38)	$715	1,550	1,200
Wall Insulation (R-3 to R-11)	$670	551	722
Furnace (AFUE 78 to 92)	$623	1,000	793
Refrigerator Replacements	$631	600	705
CFLs (packages of 16 bulbs)	$48	7,680	1,921

Implementers (GEO/Agencies)

Measures that are implemented by the participating agencies are specified by the cost-effectiveness test and the DOE guidelines. From there, the results of each individual audit determine what will be implemented, unless there are health and safety concerns in the home.

Regulatory Issues

The Public Utility Commission (PUC) has few concerns about regulating the program. If the low-income program is found to not be cost-effective, the PUC will not penalize Xcel Energy.

Technical Assumptions

According to respondents, Xcel Energy uses deemed values for all the savings. These technical assumptions are reviewed every time Xcel Energy prepares a biennial filing. While some respondents believe that savings could be more accurately calculated, there are some limitations based on the type of information collected. Agency respondents suggested obtaining a more accurate read of home size and taking actual pre- and post-measurements of home shell measures and refrigerators, as a way to obtain more accurate savings calculations.

Future Trends

Some stakeholders would like to include cooling systems in the program, especially for the elderly; however, those measures would need to be evaluated for cost-effectiveness. Additional measures that some stakeholders would like included are fixing roofs, fixing plumbing issues, and improving indoor air quality issues.

One factor that may affect the future of the program is that some federal funding will be reduced. It is currently unknown if the same level of work will be available for the agencies and whether or not there will be a reduction in services and measures provided. In 2012, LEAP funding may also be cut in half, thus potentially reducing the budget available to serve eligible participants.

Implications

Some opportunities for program improvement include the following:

- **Install an automated quality assurance process in the audit software** to save stakeholder time addressing data discrepancies after the audits have taken place.
- **When reviewing audit data, consider downloading only what is rebate eligible.** This could save time from reconciling data that do not need to be considered for program purposes.
- **Provide additional training for agencies,** and consider having the GEO spend more time accompanying technicians in the field.
- **Consider whether or not to base the cost-effectiveness of measures on more precise climate zone weather data.** There could be further efficiency gains with heightened collaboration between local, state, and federal agencies.

Process Flow Diagram

Figure 1 is the process flow diagram of the COSFW Program. Cadmus designed the diagram for Xcel Energy to provide to new program staff, to clarify program intricacies, and to show opportunities to improve program efficiency.

Logic Model

The weatherization program logic model is shown as Figure 2. Cadmus designed this logic model to be used as a tool for achieving program objectives. The logic model works by identifying program goals and the barriers that are currently preventing those goals from being achieved. Activities are identified to overcome the market barriers, and then short-term and long-term market effects are linked as the outcome of those activities. Finally, measurable indicators are identified, which will be used as a means for understanding whether or not program objectives have been achieved. Data from the measurable indicators can be used as trend data as this process continues in the future.

For the purposes of readability, we applied colors and arrows to the logic model. We assigned each objective in the model with a color, and the objective's corresponding market barriers, activities, market effects, and measurable indicators have the same color. Arrows also elucidate the flow of this process.

Figure 1. Weatherization Process Flow

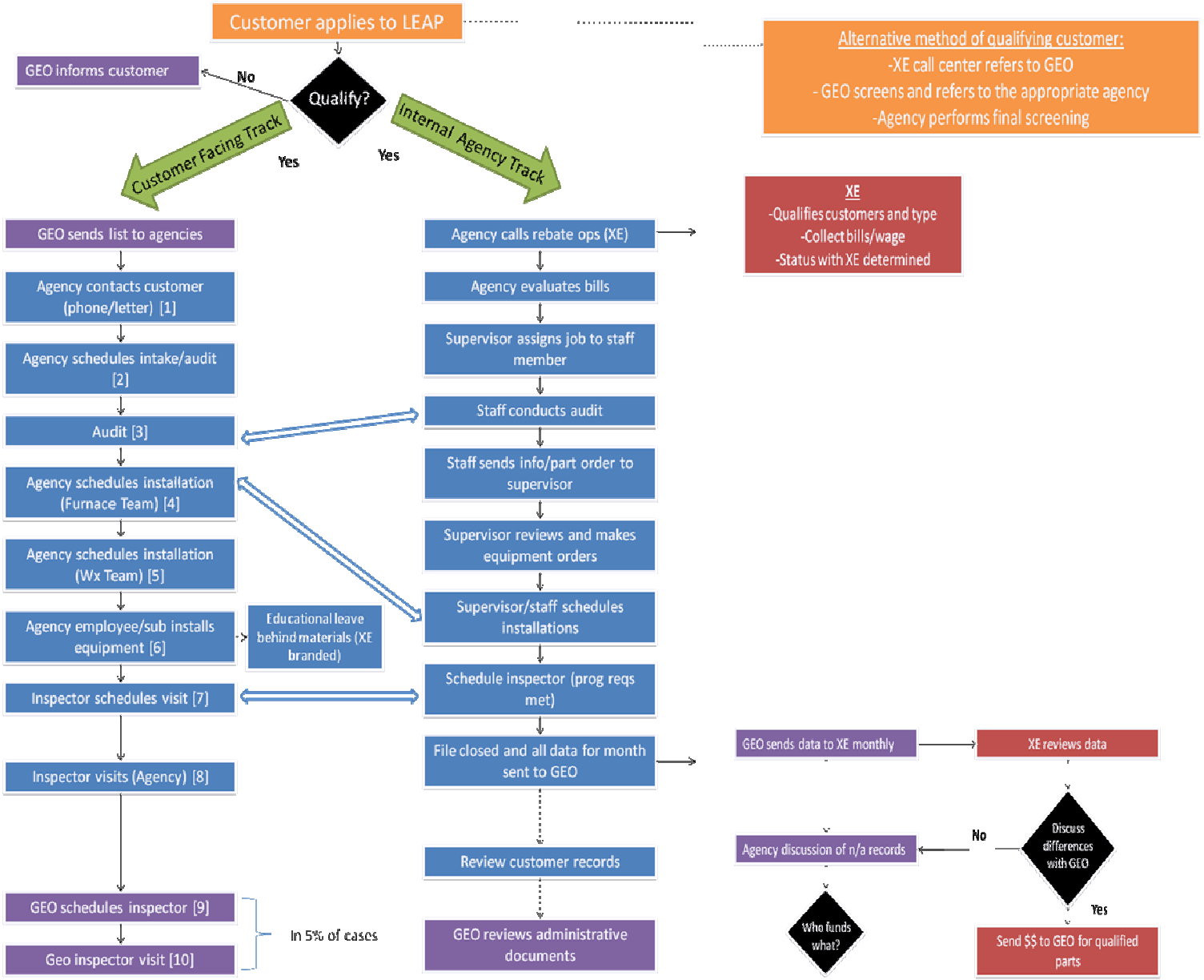
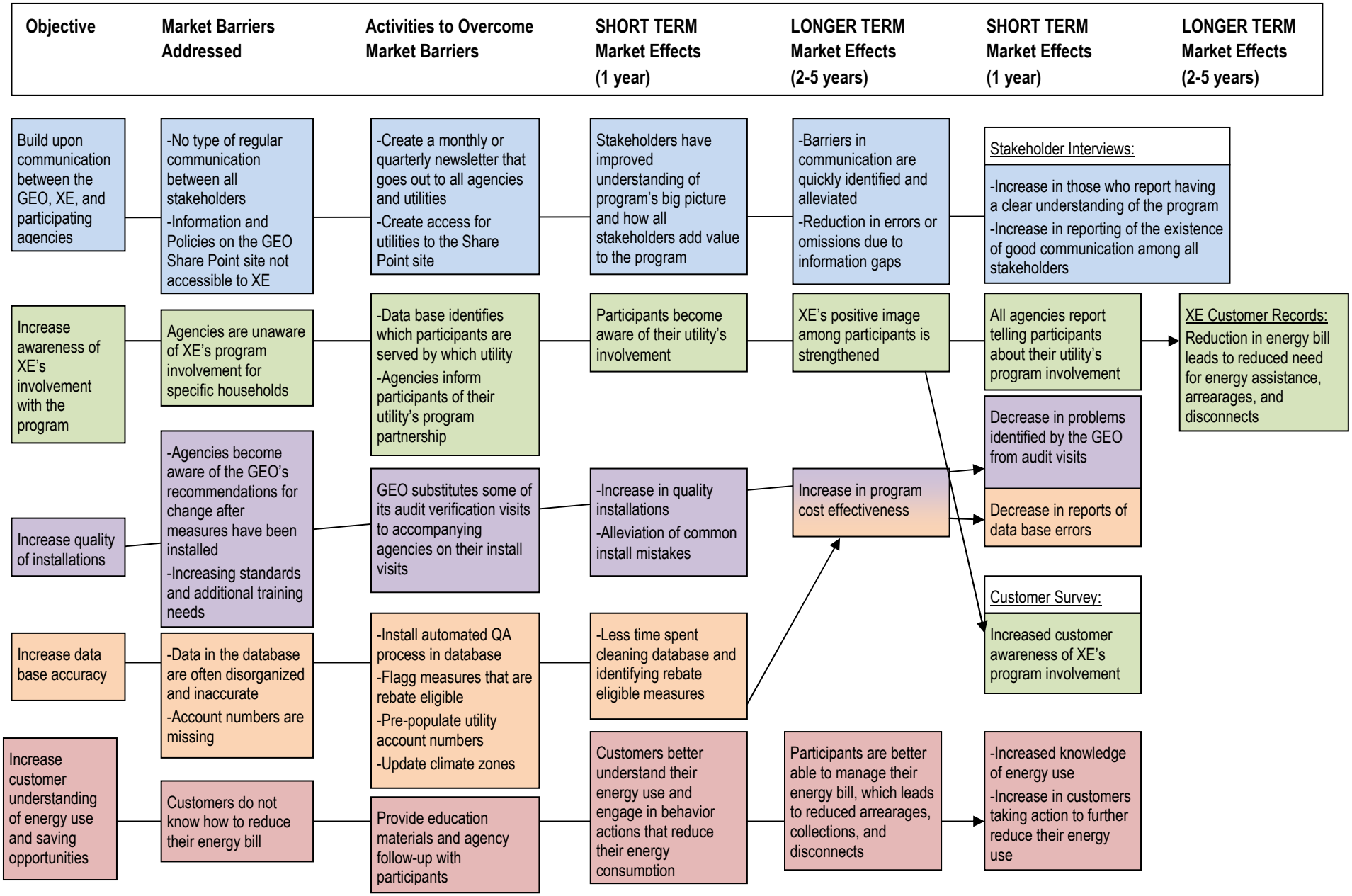


Figure 2. Weatherization Logic Model



4. Participant Surveys (Task 3)

Summary of Participant Key Findings

The following is a summary of findings from the participant surveys:

- **Program awareness.** The majority of participants (59%) initially learned about the program either through word-of-mouth or from LEAP/LIHEAP. Mass media, including TV and newspaper ads, bill inserts, and online sites informed an additional 21 percent of surveyed participants about the program (Figure 3).
- **Awareness of Xcel Energy as a program sponsor**. Nearly two-third of participants (61%) were unaware that Xcel Energy is a program sponsor.
- **Reason for participation.** Over half (56%) of surveyed participants stated they participated in the program because their home needed a specific measure that the program offered. Another one-third (34%) of participants stated high energy bills as their motivation to participate (Figure 5).
- **Satisfaction.** Overall, the participants surveyed were very satisfied with the weatherization program equipment that was installed in their home (96% rated it a 6-10 on a scale from 0-10, where 0 means not at all satisfied and 10 means completely satisfied).

Methodology

PRS conducted 381 surveys with participants, asking questions regarding program awareness, satisfaction, marketing, barriers, and demographics. These surveys were conducted at a 95/5 confidence precision level.

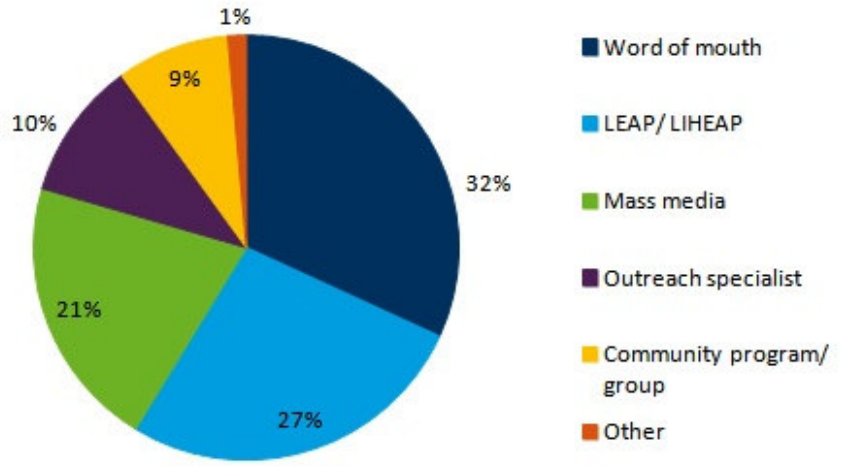
Participant Detailed Findings

The detailed findings determined from the participant surveys are provided below.

Program Awareness

One-third (32%) of participants learned about the program through word-of-mouth and another 27 percent became aware of the program through their involvement with LEAP or LIHEAP. Mass media, including TV and newspaper ads, bill inserts, and online sites informed an additional 21 percent of surveyed participants about the program.

Figure 3. How Participants Learned About the COSFW Program



Source: Question B1. How did you first find out about the weatherization program? (n=361)

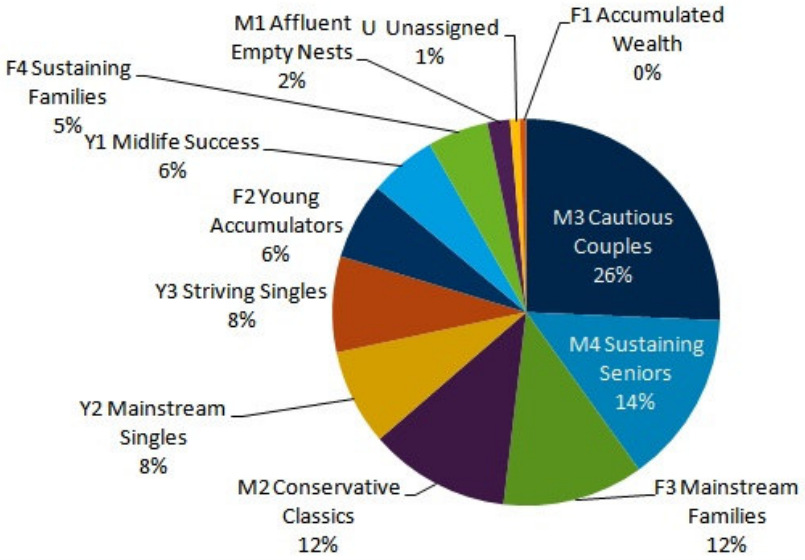
- Just over one-third of participants (39%) were aware that Xcel Energy is a sponsor of the program. Of these participants, two-thirds (62%) learned of Xcel Energy's role in the program through means such as LEAP, word-of-mouth, bill inserts, Xcel Energy representatives, and county representatives.
- When asked where they would go to learn about how to save energy, just over one-third (39%) of participants surveyed would reference a Website and just under one-quarter (24%) would use other sources, such as calling Xcel Energy directly.
- Most participants surveyed stated that their familiarity with energy equipment increased through their involvement in the weatherization program; 34 percent stated their familiarity increased significantly and an additional 42 percent stated that it increased somewhat. An additional 24 percent stated that it remained the same.

PRIZM Segments

Cadmus analyzed respondents within the PRIZM[3] segments provided by Xcel Energy. Because PRIZM segments use income as one of the factors in defining segments, we expected most respondents from this program to cluster into two to three life stage categories. Figure 4 shows the distribution of program participants across the life stages. Just over one quarter (26%) of respondents were classified as Cautious Couples. Sustaining Seniors (14%), Mainstream Families (12%), and Conservative Classics (12%) made up another third of respondents.

[3] Nielsen, Claritas: http://www.claritas.com/MyBestSegments/Default.jsp

Figure 4. Respondent PRIZM Life Stage Categories



Although the highest proportion of respondents was in the expected low-income categories, the distribution across all life stage categories was broader than anticipated. This may reflect the effects of recent economic conditions in which high unemployment likely contributes to an increase in low-income eligibility from a broader cross-section of households.

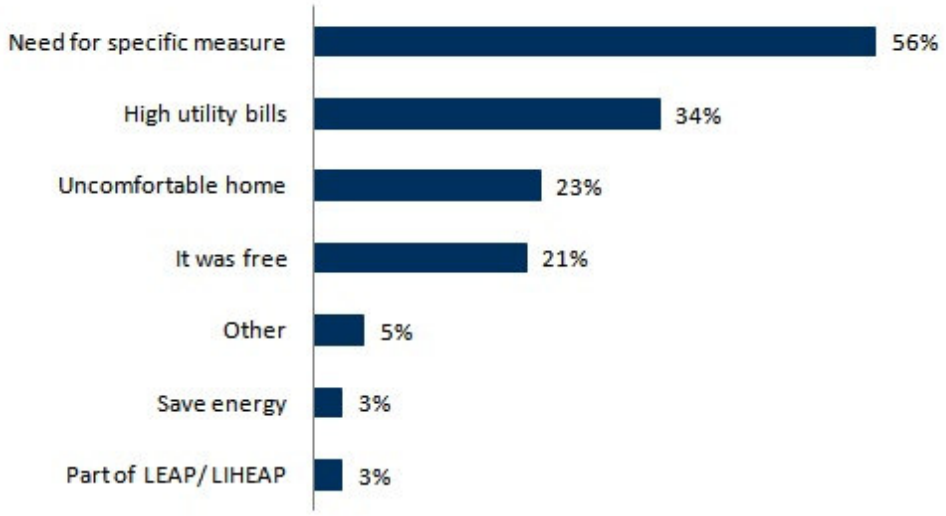
Segment Differences

- More Cautious Couples (66%) and Mainstream Families (71%) were unaware that the program was sponsored by Xcel Energy than Striving Singles (45%).
- Significantly more Conservative Classics (52%) had 0 CFLs installed during the visit.
- More Striving Singles live in Mobile or manufactured homes (57%) and live in smaller homes (Less than 1,000 square feet)
- Sustaining Seniors (19%) were more likely to look for information about how to save energy in newspapers or magazines. Striving Singles (47%), Midlife Success (43%), Sustaining Seniors (39%), Cautious Couples (38%), and Conservative Classics (36%) were more likely to live alone than other groups.
- Young Accumulators (29%) were more likely to live in households of 5 or more.

Reason for Participation

Over half (56%) of surveyed participants stated they participated in the program because their home needed a specific measure that the program offered. Just over one-third (34%) of participants stated high energy bills were their motivation to participate. An additional 23 percent stated that they participated due to an uncomfortable home, and 21 percent stated they participated because the program was free.

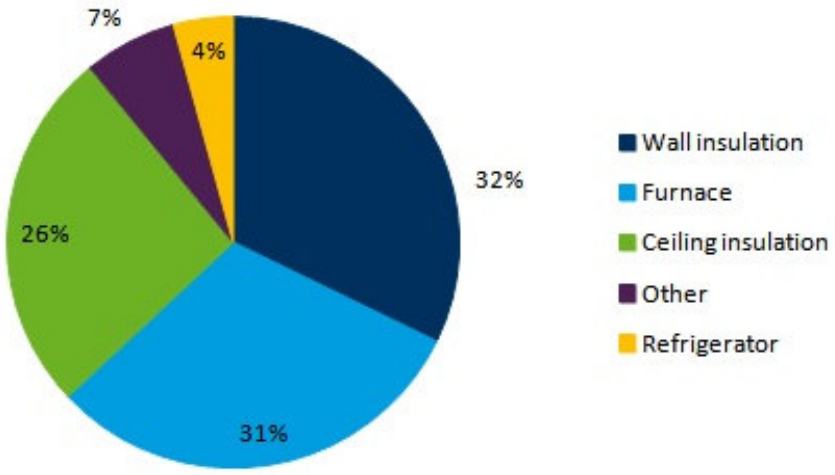
Figure 5. Main Reason for Program Participation



Source: Question B2. What was the main reason you decided to participate in the Program? (n=377, multiple responses allowed).

Of the 56 percent of participants who claimed a need for a specific measure as their reason for participating, nearly one-third (32%) claimed wall insulation as the measure their home needed and another almost one-third (31%) needed a new furnace.

Figure 6. Specific Measures Mentioned as Reason for Participation (n=211)

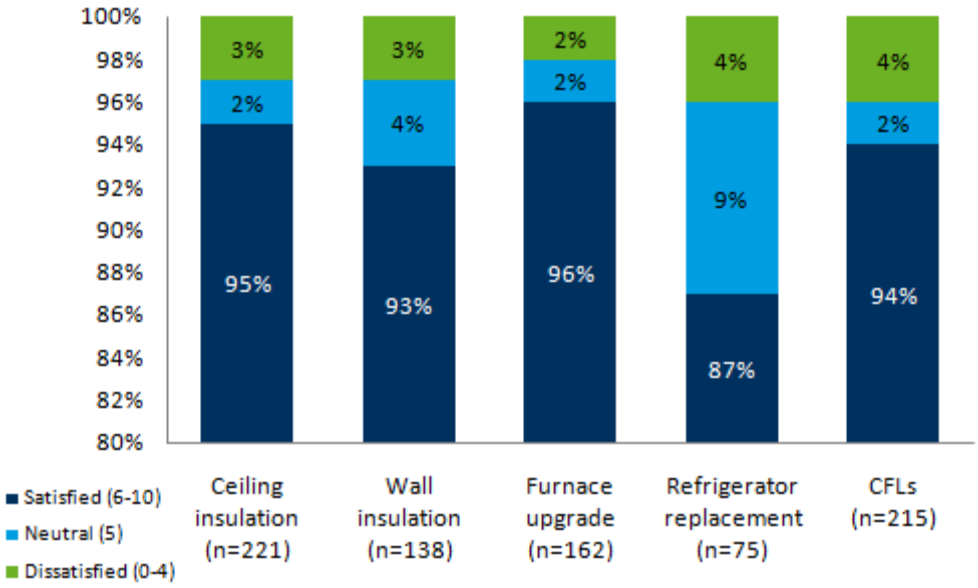


Satisfaction

Overall, the participants surveyed were very satisfied with the weatherization program equipment that was installed in their home (96% rated it a 6-10 on a 0-10 scale). Satisfaction

ratings for each individual measure (not the installation, strictly the measure equipment) were also high, as seen in Figure 7.

Figure 7. Satisfaction with Energy Saving Equipment Installed Through Program



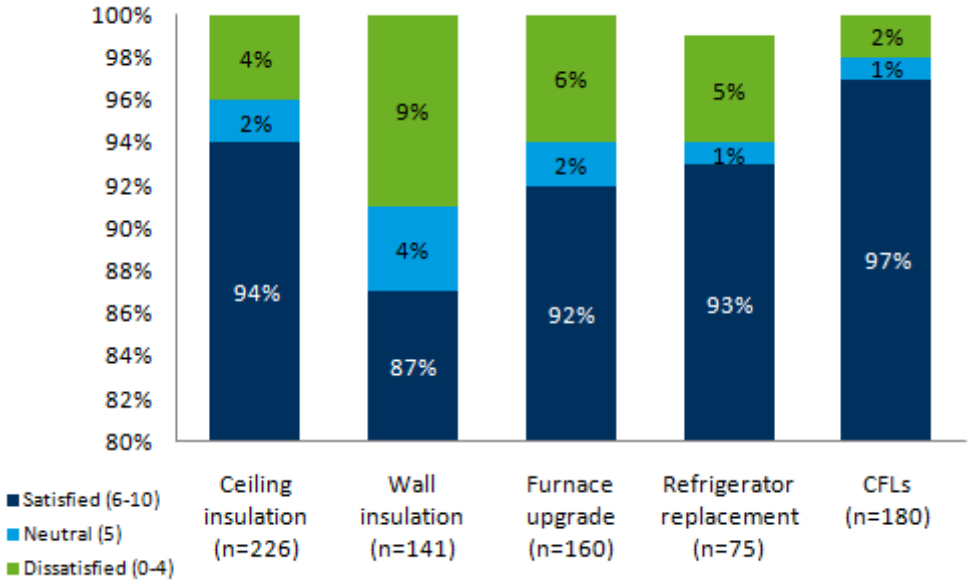
Source: Questions C2-C10. How satisfied are you with the [energy saving equipment] that was installed in your home through the weatherization program?

Participants were also asked to rate their satisfaction with the installation of program measures. While these ratings were also high, they were lower than their satisfaction for the individual measure in the cases of ceiling and wall insulation and furnace upgrades (see Figure 8). The reasons listed for this decrease in satisfaction were:

- Ceiling and wall insulation
  - **Multiple responses mentioning the quality of the work**: "*The technicians did not repair holes from the ceiling insulation- they just threw plaster over and said we'd have to fix that ourselves. We have a bunch of little holes on the ceiling in every* room," "….inconsistent in the installation and they did not clean up their work- more work for me," "Some of the people were not the best craftsmen-didn't do a good job of replacing the siding that they removed to put the insulation in the walls."
  - **Multiple responses mentioning concern over breathing in particles from the insulation:** *"My kids have asthma and it was dusty and they tracked dirt into the house," "I am concerned about breathing in the particles when they blow that stuff in," "…sprayed insulation all over the house…still taking insulation out from where they blew it around the furnace."*
- Furnace upgrade
  - **Multiple responses mentioning plumbing issues post-installation: "***Had to redo plumbing as a result, still have a water leak-everything was sloppy…very unhappy with them," "…had to call them back four times for leaks."*

- **Multiple responses mentioning thermostat issues:** "*They would not come out and help me program the thermostat when I called them. I can't figure it out,*" "*They initially promised a new thermostat, but still have old one. It was finally replaced by a different company (Green Jobs), plus they left vent holes in the basement unfinished and somewhat uninsulated.*"

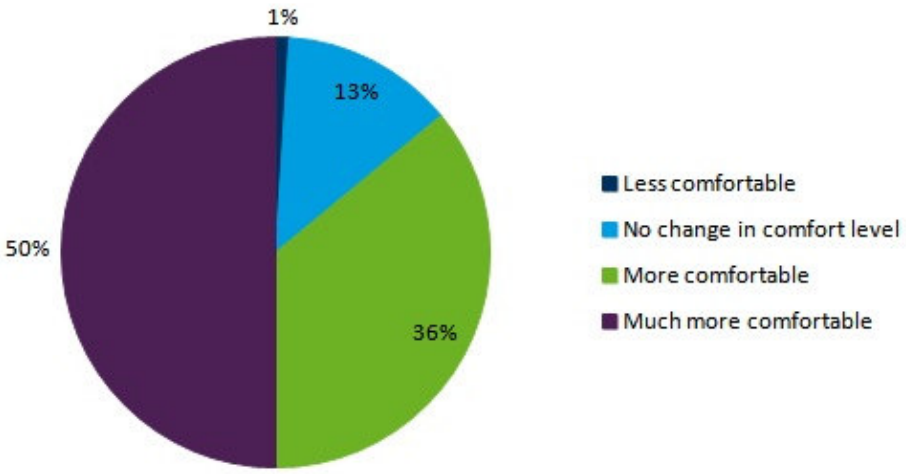
Figure 8. Satisfaction with Installation



Source: Question C12a-C12e. How satisfied were you with HOW the energy saving equipment was installed in your home?

- The information the installer provided received high satisfaction ratings (95% positive).
- The majority of participants surveyed (86%) stated that their homes became more comfortable as a result of the program; of that 86 percent, just over one-third (36%) stated it was more comfortable and half (50%) stated it was much more comfortable. Just over one-tenth (13%) stated that the comfort of their home remained the same (see Figure 9).

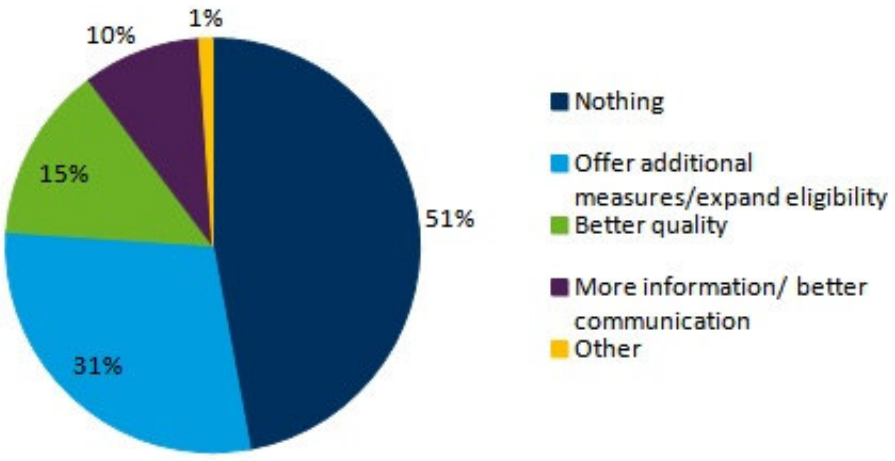
Figure 9. Home Comfort Level After Weatherization Upgrades



Source: Question C14. Thinking about the comfort level of your home since the weatherization upgrades were installed, has it been…? (n=376)

- Three-quarters of surveyed participants (75%) stated that they think their monthly energy bill has decreased since the weatherization visit.
- When asked what changes participants would make to the program, just over half (51%) stated that they would change nothing (see Figure 10). Just under one-third (31%) of participants, however, stated they would offer additional measures or expand the eligibility of the existing measures to additional customers. Fifteen percent said they would increase the quality of the program. Customer service, equipment, installers, and inspections were mentioned as areas needing quality improvement.

Figure 10. Changes That Would Improve the Program



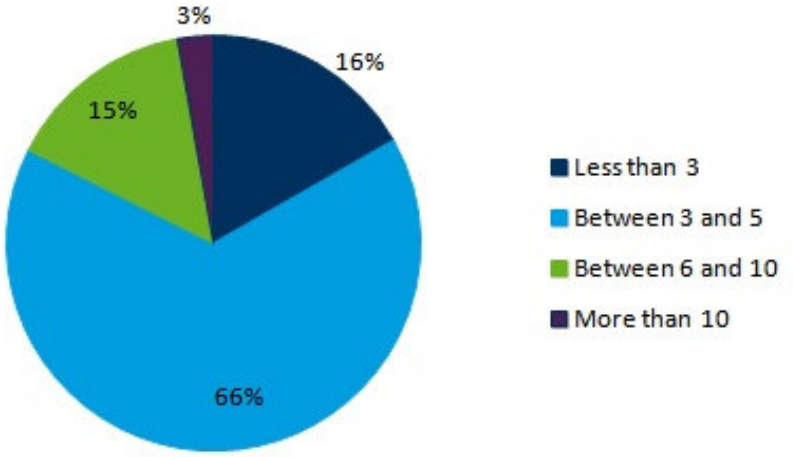
Source: Question C16. What would you change to make the Program better? (n=350, multiple responses allowed)

- Just over two-thirds of participants surveyed (66%) reported that the auditor did not provide them with additional ways to save energy. Of the just over one-third (34%) of surveyed participants that noted that they did receive information from the auditor on additional ways to save energy, 40 percent learned about window and door replacement, 15 percent learned about weather stripping or caulking, and nine percent learned about measures that they did not qualify for. Also, there were many varying additional ideas provided, although only in small percentages; thus leading us to believe that there is some educational information being provided at the auditor level that could be specific to each home (such as caulking, storm windows, heater vents, thermostat settings, a cooling system, etc.).

Market Barriers

- One potential barrier for this program is the wait time for acceptance into the program; however, half of the surveyed participants (50%) stated that they waited less than one month from their application to learning they were accepted into the program. Just under one-quarter of additional participants surveyed (24%) stated that they waited between 1-2 months, and an additional eight percent reported waiting between 2-3 months to learn of their acceptance into the program.
- From the program acceptance to the initial visit, the majority (54%) of surveyed participants waited less than two weeks; just over one-quarter (26%) waited between 2-4 weeks and just over one-tenth (14%) waited between 1-2 months for their initial visit.
- A majority of respondents indicated that their participation required numerous separate visits from technicians to their home: 18 percent of participants surveyed reported that they received six or more on-site visits throughout their participation in the program, 16 percent received five visits, 19 percent received four on-site visits, and 30 percent reported receiving three visits.

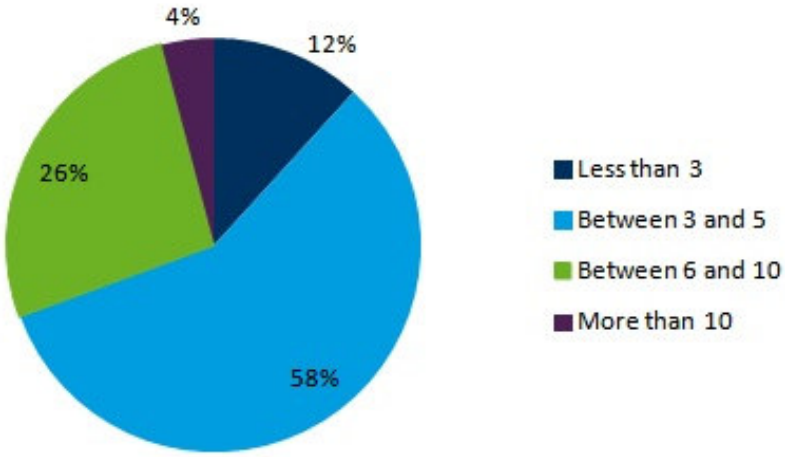
Figure 11. Number of On-Site Visits Received by Participants



Source: Question D5. Altogether, how many in-home visits did you receive throughout your participation in this program? (n=359)

- Twelve percent of participants surveyed stated that they received six telephone calls throughout their participation in the program; 15 percent received five calls, 22 percent received four calls, and 21 percent received three calls.

Figure 12. Number of Telephone Calls Received by Participants



Source: Question D6. Altogether, about how many telephone calls did you receive throughout your participation in this program? (n=340)

Demographics

- The majority of participants surveyed own their home (87%) and the remainder rent their home (13%).

- The dominant housing type is a single family detached home (80%). Less than one-quarter of surveyed participants (14%) live in a mobile home.
- The amount of time participants have lived in their home is split nearly down the middle. Just over half of surveyed respondents (52%) have lived in their home over a decade while just under half (48%) have lived in their home 10 years or less.
- The dominant source for water and home heating is gas (89% for water and 90% for gas).
- Just under half (44%) of participants surveyed have a high school education or less, just over one-third (37%) have some college, and just under one-sixth (15%) have a bachelor's degree.
- Just under one-third (32%) of participants live in their home alone, 28 percent live in a two-person household, and 15 percent live in a household of three people.
- The dominant age range for participants surveyed was 65 years or older (37%). The next age range was 55-64 years (21%) followed by 45-54 (18%).

Recommendations

- **Consider working with implementers** to ensure that they mention Xcel Energy as the program sponsor when they are on-site speaking with customers (if it is important that customers are able to identify Xcel Energy as a program sponsor).
- **Consider working to expand the participation of renters** in the program by working with multifamily buildings and landlord/tenant agreements.
- **Consider conducting some quality control visits.** Presently, some customers have expressed concerns regarding the quality of furnace and insulation installations in particular.

5. Net-To-Gross Ratio (Task 5b)

The NTG ratio for the COSFW Program is assumed to be 1.0 per the Colorado Public Utilities Commission recommendation for low-income programs. Cadmus therefore did not calculate net verified savings for this program.

6. Site Visit Verification (Task 9)

Cadmus visited 50 homes in Colorado that had Xcel Energy COSFW Program measures installed. Cadmus conducted a visual inspection of the measures, an infrared camera inspection of applicable measures, ran REM/Rate with the site visit findings to verify savings, and created this report of findings. While on site, we collected data such as:

- Foundation type
- Home type: mobile home or site built
- Attic or wall insulation
- Furnace data
- Cooling system identification
- Duct work
- Refrigerator information
- Appliance information: type and fuel
- Lighting
- Windows and doors

The site visit data collection form is available as Appendix A.

Note: In order to increase the readability of this chapter, we present findings from the on-site verification visits. Some of this information is repeated in the Baseline and Technical Assumptions Analysis chapter, as these site visits informed part of our technical assumptions review.

Summary of Key Findings

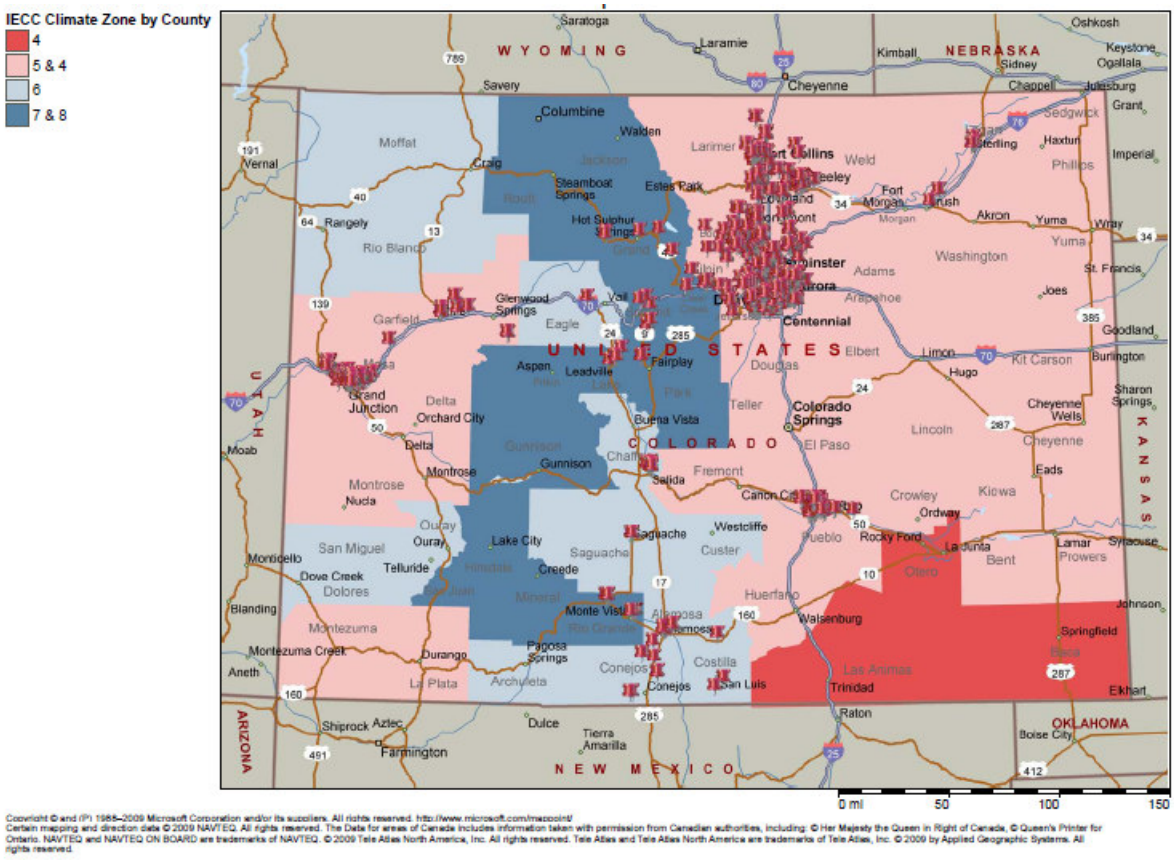
- **Number of Bedrooms and Home Square Footage.** Of the 50 homes Cadmus visited, the average number of bedrooms for site-built homes was three, and for mobile homes was two. The average conditioned size of site-built homes was 1,452 square feet, and for mobile homes was 1,030 square feet.
- **Attic Insulation.** Almost half (23 of 50) of the sites we visited received program attic insulation. The majority (15 of those 23) achieved the minimum insulation R-38 requirement.
- **Furnaces.** Just over one-quarter (14 of 50) of the sites we visited received a new furnace through the Xcel Energy program. Cadmus verified the AFUE for 13 of those furnaces, and determined that eight met or exceeded the minimum requirement of a 92 AFUE rating.
- **Refrigerators.** All new refrigerators under the program met the ENERGY STAR® requirement.

- **CFLs.** Thirty-two of the sites we visited received program CFLs. The majority (21 of 32) of homes did not have all 16 CFLs installed. The average number of CFLs installed in mobile homes was 10.3, and the average for site-built homes was 13.8.
- **Portion of Mobile Homes.** Twenty percent of the 50 homes we visited were mobile homes.

Methodology

Cadmus conducted site visit verification at 50 homes across Colorado. We mapped out the Colorado climate zones (specifically 4, 5, 6, and 7) and superimposed the Xcel Energy participants onto that map (see Figure 13).

Figure 13. Total Weatherization Sample with Climate Zones



As seen in Figure 13, climate zone 4 exclusively covers a small portion of the southeastern part of the state where Xcel Energy does not have service territory, and thus no participants appear within this area of the map. Climate zone 5 & 4 covers most of the eastern part of the state and a section of the western third of the state. Xcel Energy's major customer clusters in this area are in Boulder, Denver, Fort Collins, Grand Junction, and Pueblo. Cadmus visited 40 homes in this climate zone, splitting the visits across the eastern and western sections of the zone, where the participants were predominantly located.

Cadmus visited two homes in climate zone 6, which is scattered across the northwestern corner of the state and some areas in the southwest. Xcel Energy's primary participant area in climate zone 6 is Alamosa. Climate zone 7 & 8 cover the mountainous areas of central Colorado, and Xcel Energy's primary participants in this area are in the northern central band of this climate zone. Cadmus visited eight homes in climate zone 7 & 8.

Cadmus sampled within the participant climate zones and achieved the following breakdown:

- Eighty percent of homes visited were in International Energy Conservation Code (IECC) climate zone 5 & 4 (40 homes).
- Four percent of the homes visited were in IECC climate zone 6 (two homes).
- Sixteen percent of the homes visited were in IECC climate zone 7 & 8 (eight homes).

See Figure 14 for the Colorado climate zones with Xcel Energy COSFW Program participants that received verification visits as a part of this evaluation effort.

Figure 14. Site Visit Weatherization by Climate Zone

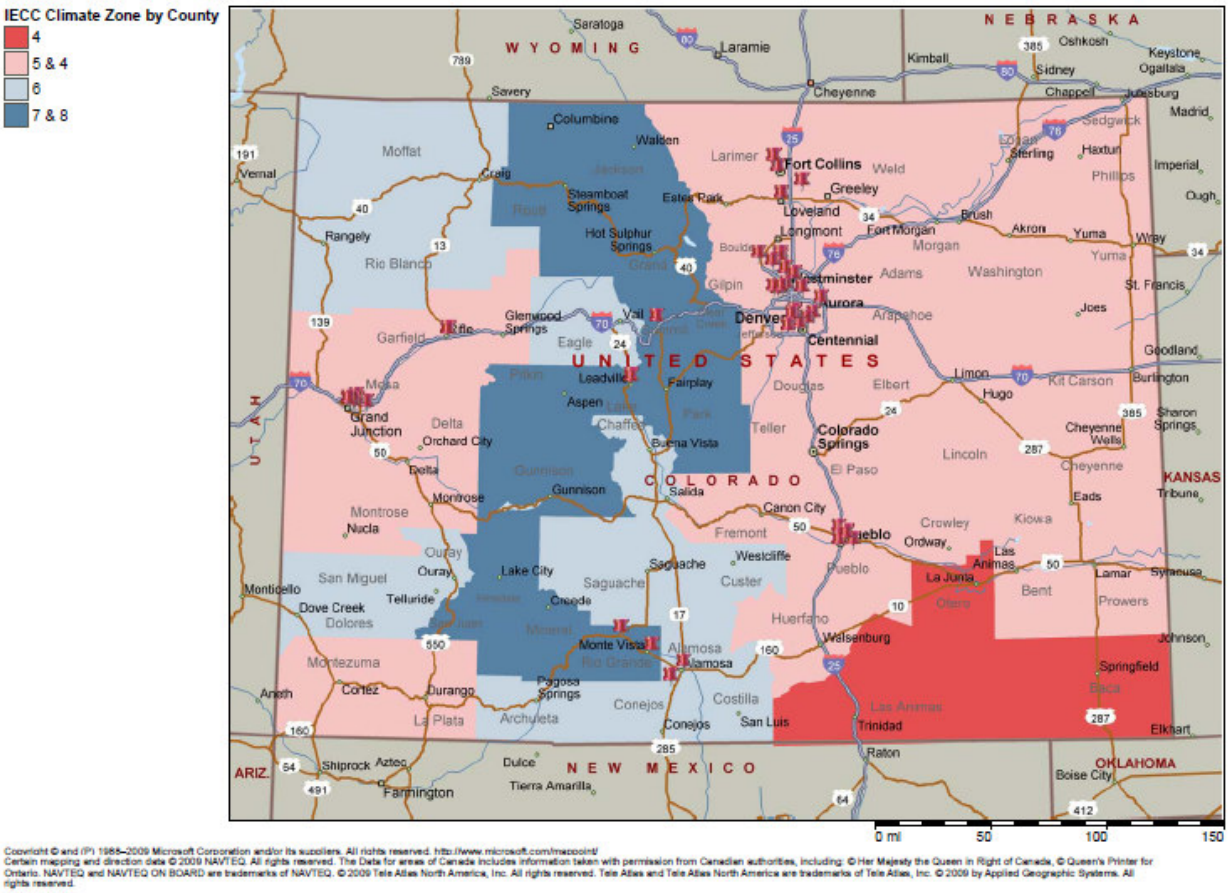


Table 2 provides the site visit location groupings that Cadmus visited, as well as the climate zones these participant homes are located in.

Table 2. Site Visits Grouped by Location and Climate Zone

Location	Number of Homes Visited	Climate Zone
Alamosa	2	6
Arvada	3	5 & 4
Aurora	2	5 & 4
Boulder	1	5 & 4
Broomfield	1	5 & 4
Centennial	1	5 & 4
Commerce City	1	5 & 4
Del Norte	2	7 & 8
Englewood	3	5 & 4
Erie	1	5 & 4
Fort Collins	1	5 & 4
Grand Junction	9	5 & 4
Greenwood Village	1	5 & 4
Lafayette	1	5 & 4
Laporte	1	5 & 4
Leadville	4	7 & 8
Littleton	1	5 & 4
Louisville	1	5 & 4
Loveland	1	5 & 4
Monte Vista	1	7 & 8
Northglen	1	5 & 4
Palisade	1	5 & 4
Pueblo	5	5 & 4
Rifle	2	5 & 4
Silverthorne	1	7 & 8
Westminster	1	5 & 4
Windsor	1	5 & 4

Findings

Findings from the following measures are outlined below:

Natural Gas Measures

- Furnace efficiency upgrades
- Wall insulation
- Ceiling insulation

Electric Measures

- Refrigerator replacements
- CFLs (installation of 16 per home)

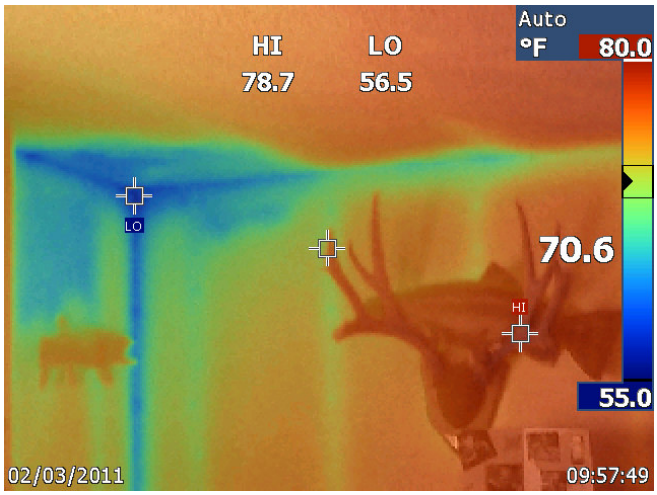
Furnace Efficiency Upgrades

Cadmus recorded the furnace make, model, serial number, and output kBtuh at each residence we visited, excluding homes without a furnace or one case where it was inaccessible. Fourteen of the 50 sites we visited received new furnaces under the program. Cadmus was only able to verify the AFUE for 13 of those furnaces, because one furnace was located in an inaccessible attic. Of those 13, eight met or exceeded the minimum requirement of a 92 AFUE rating. The five furnaces that did not meet the program requirements were all 90 AFUE. Cadmus used 92 AFUE to determine furnace savings, as this is the program requirement.

Wall Insulation

Physical inspection of wall insulation is not feasible once a residence is fully built. Cadmus used infrared cameras to take thermographic images of each residence (see Figure 15), then assigned a RESNET® insulation grade of II or III as provided in the REM/Rate models. Since grade I can only be given with a visual inspection, Cadmus did not assign a grade I to any wall inspection. The photo in Figure 15 shows a temperature differential in the corner of the room indicating the insulation in the ceiling and walls may not have been applied evenly or thoroughly in this home. This photo, while not typical of all the homes visited, shows an example of a problem with the insulation. If a GEO inspector were to observe something similar, a crew would be deployed to correct the problem.

Figure 15. Infrared Photograph of Home Interior



Ceiling Insulation

While on-site, Cadmus verified whether insulation was installed and its final R-value. Twenty-three of the 50 sites we visited received ceiling insulation. Of those 23, 15 met the R-38 requirement. The eight homes with ceiling insulation that did not meet the program requirements had R-values ranging from 20 to 36. These eight homes were also distributed evenly across the service territory, indicating the problem was not limited narrowly to a specific installer. Cadmus used the program requirement of R-38 to determine the recommended savings, because residents did not control the amount of insulation that contractors installed in their attic.

In addition to the physical inspection, Cadmus used thermographic imaging to inspect the quality of installation, then assigned a RESNET insulation grade of I, II, or III as provided in the REM/Rate models.

Refrigerator Replacements

Cadmus verified whether each residence had a dishwasher and a cooling system, and the fuel types of the stove and dryer. We modeled the fuel and appliances variations, and found that they have no impact on the annual heating consumption of the homes. Xcel Energy does not offer low-income cooling savings, so we did not model homes with cooling systems, and therefore did not review annual cooling consumption. Based on the data we collected during verification site visits and in-situ studies, we recommend updated assumptions for the refrigerator adjusted volume and degradation factor. These recommendations are outlined in the Baseline and Technical Assumptions Analysis chapter.

CFLs

Thirty-two of the homes we visited received program CFLs. During the verification site visits, Cadmus found that the majority of homes did not have all 16 program CFLs installed. The average number of CFLs installed in mobile homes was 10.3, and the average for site-built homes was 13.8. The average site-built home we visited has 29.5 sockets, and the average mobile home we visited has 21.75 sockets. Cadmus did not inventory the quantities or types of bulbs that residents had in storage.

Recommendations

- **Consider collecting the square footage and home type** for electric-only homes, as this information is already being collected for gas and combined homes.
- For homes with fewer sockets than the maximum bulbs allowed, **consider providing a one-for-one CFL replacement** and have the contractor invoice per bulb based on the individual home/mobile home socket count.

7. Baseline and Technical Assumptions Analysis (Task 5c)

This chapter provides an engineering analysis of the COSFW Program DSTA section of the 2009/2010 Filing.

Summary of Key Findings

- Cadmus assessed the Xcel Energy technical assumptions to verify which assumptions are supported by current technical references, and to identify assumptions for which updated values and techniques may be warranted based on recent studies and findings from our 2011 site visits**. Xcel Energy's current savings and Cadmus' recommended savings are listed in Table 3.**
- Cadmus reviewed 25 technical assumptions from the DSTA. **Cadmus identified 11 assumptions for which updated values should be considered.** Table 3 defines the DSTA assumptions that we reviewed, and whether we verified the assumption or recommend an updated value.

Table 3. Comprehensive List of all Reviewed DSTA Technical Assumptions and Recommendations

Assumption		DSTA Value	Evaluation Result	Margin of Error	Home Type	Recommendation
REM/ Rate	Home Type	Site Built	Mobile and Site Built	N/A	Specified	Consider using deemed savings values for mobile and site built homes.
	Location	Denver	Multiple Regions	N/A	Both	Consider assigning deemed values for various regions.
	Conditioned Floor Area	961 Square Feet	Verified	1022 ±165.9	Mobile	Continue use of DSTA value for mobile homes.
			1,452 Square Feet	1452 ± 213.1	Site Built	Consider updating model assumption with evaluation result.
	Number of Bedrooms	Two	Verified	N/A	Mobile	Continue use of DSTA value for mobile homes.
			Three	N/A	Site Built	Consider updating model assumption with evaluation result.
	Foundation Type	Crawlspace	Open Crawlspace	N/A	Mobile	Consider updating model assumption with evaluation result.
			Enclosed Crawlspace	N/A	Site Built	Consider updating model assumption with evaluation result.
	Foundation Wall Type	Uninsulated	Mobile Home Skirt	N/A	Mobile	Consider updating model assumption with evaluation result.
			R-11 Draped Insulation	N/A	Site Built	Consider updating model assumption with evaluation result.
	Home Complexity	Four Corners	Verified	N/A	Both	Continue use of DSTA value.
	Nominal Ceiling Height	N/A	7.6 Feet Mobile	N/A	Mobile	Consider defining ceiling height for model input.
			8.2 Feet Site Built	N/A	Site Built	Consider defining ceiling height for model input.
	Ceiling Type Baseline	R-11	REM/Rate Mobile Default	N/A	Mobile	Consider using REM/Rate mobile home default to model mobile homes.
			Verified + Include Grade III	N/A	Site Built	Consider the baseline of R-19.
	Ceiling Type Weatherized	R-38	Verified + Grade II	N/A	Both	Continue use of DSTA value considering use of evaluated grading.
	Above Grade Wall Type Baseline	R-0 to receive measure R-3 otherwise	REM/Rate Mobile Default	N/A	Mobile	Consider updating model assumption for mobile homes.
			Empty Cavity Insulation R-4.37 Grade III	N/A	Site Built	Consider updating model assumption with evaluation result including grading.

Assumption		DSTA Value	Evaluation Result	Margin of Error	Home Type	Recommendation
	Above Grade Wall Type Weatherized	R-11	Verified + Grade III	N/A	Site Built	Continue use of DSTA value considering use of evaluated grading.
	Foundation Floor Type	N/A	R-9.3	N/A	Mobile	Consider defining foundation floor type assumption.
			Uninsulated	N/A	Site Built	Consider defining foundation floor type assumption.
	Door Type	N/A	R-1.7	N/A	Both	Consider defining door type assumption.
	Infiltration Rate	0.8	Verified	0.67 ± 0.19	Mobile	Continue use of DSTA value.
				0.67±0.18	Site Built	
	Window Properties	U-Value 1.27 SHGC 0.75	U Value 0.86 SHGC 0.72	0.86±0.015 0.72±0.005	Mobile	Consider redefining window properties based on evaluation findings.
			U Value 0.75 SHGC 0.67	0.75±0.0055 0.67±0.0017	Site Built	Consider redefining window properties based on evaluation findings.
		Area is 15% if Conditioned Floor Area = 144.15 sq. ft.	108.25 sqft	108.25±17.9	Mobile	Consider redefining window properties based on evaluation findings.
			Verified	156.75±20	Site Built	Continue use of DSTA value of 144.15.
	Furnace Baseline Properties	78 AFUE, Size Not Defined	Verified AFUE, 57.9 kBtuh	N/A	Mobile	Consider using evaluation finding for furnace size.
			Verified AFUE, 65.9 kBtuh	N/A	Site Built	Consider using evaluation finding for furnace size.
	Furnace Weatherized Properties	92 AFUE, Size not defined	Verified AFUE, 57.9 kBtuh	N/A	Mobile	Consider using evaluation finding for furnace size.
			Verified AFUE, 65.9 kBtuh	N/A	Site Built	Consider using evaluation finding for furnace size.
	Duct System Properties	Insulated to R-4	R-9.3	N/A	Mobile	Consider using evaluation value to model mobile home ducts.
			Uninsulated	N/A	Site Built	Consider using evaluation value to model site-built home ducts.
		25% Duct Leakage	Verified	N/A	Both	Continue use of DSTA value.
	Appliances	85% Have Dishwashers 74% Have	Verified	N/A	Both	Continue use of DSTA values.

Assumption		DSTA Value	Evaluation Result	Margin of Error	Home Type	Recommendation
		Electric Ranges 88% and 89% Have Clothes Washer and Electric Dryer 68% Have Ceiling Fans				
Refrigerators	Adjusted Volume	23.47 and 23.66 Cubic Feet	21.58 Cubic Feet	21.58 ±1.53	Both	Consider using evaluation adjusted volume finding.
	Survival Rate	Dependent on Age	Verified	N/A	Both	Continue use of DSTA values.
	Degradation	1.037%	1.25%	N/A	Both	Consider using evaluation degradation factor.
CFLs	Operating Hours	2.78	Verified	N/A	Both	Continue use of DSTA value.
	Coincidence Factor	8%	Verified	N/A	Both	Continue use of DSTA value.
	CFLs Installed	16	10.3	10.25 ± 2.88	Mobile	Consider using actual CFL savings per bulb installed
			Verified	13.8±2.9	Site Built	Consider using actual CFL savings per bulb per bulb installed

Table 4 contains Xcel Energy's current deemed energy and demand savings for the COSFW Program measures.

Table 4. Xcel Energy's 2010 Deemed Savings

Measure	Gas Savings (Dth)	Electric Savings (kWh)	Demand Savings (kW)
Ceiling Insulation*	7.9	1,843	0.867
Wall Insulation*	18.7	4,362	2.052
High-Efficiency Furnace	11.1	-	-
Refrigerator Replacement	-	584	0.08
16 CFLs	-	752	0.74

* Electric and demand savings from insulation are for residences with electric heat. Dth insulation savings are for residences with furnaces.

Cadmus did not review demand savings for insulation measures in electrically heated homes, as none of the homes in the site visit sample had electric heat. Also, mobile homes are not currently considered in the DSTA, and calculating these modeled savings would not affect the gross verified savings.

Method

For the engineering analysis, Cadmus developed deemed savings assumptions to calculate the energy savings based on program measures through a variety of techniques. For ceiling insulation, wall insulation, and high-efficiency furnaces, we used REM/Rate modeling to simulate residential gas and energy baseline consumption, as well as gas and energy consumption post-measure(s) installation. We built the models for both site-built homes and mobile homes to reflect the average characteristics of each home type. Cadmus calculated the energy savings for each individual measure, as well as the interactive effects of installing the measures together.

Cadmus calculated refrigerator deemed savings using the characteristics we observed for new refrigerators during the site visits. Cadmus used federal standards from 1990 vs. current ENERGY STAR standards to determine year one energy and demand savings. We determined CFL savings using incandescent baseline wattages and the wattage for CFLs with comparable lumen output. We also accounted for the installation rate observed in the field when determining the recommended deemed CFL savings.

Cadmus followed Xcel Energy's defined rigor for recommending updated values for assumptions found in the DSTA. Using 90 percent confidence, Cadmus found the margin of error for applicable assumptions. If the current DSTA assumption was within the margin of error, then Cadmus advised the continued use of the DSTA value as defined by Xcel Energy. If the current DSTA was outside of the margin of error, then Cadmus recommended updated values for Xcel Energy to consider.

REM/Rate Modeling

Table 5 through Table 8 show the Cadmus-modeled measure savings using REM/Rate version 12.85. We noted savings for Dillon, Eagle, Grand Junction, and Leadville to illustrate the variation in savings from region to region. Cadmus identified specific climate zones in Xcel

Energy territory that affected the modeling due to variations in altitude. These savings are based on the verification findings.

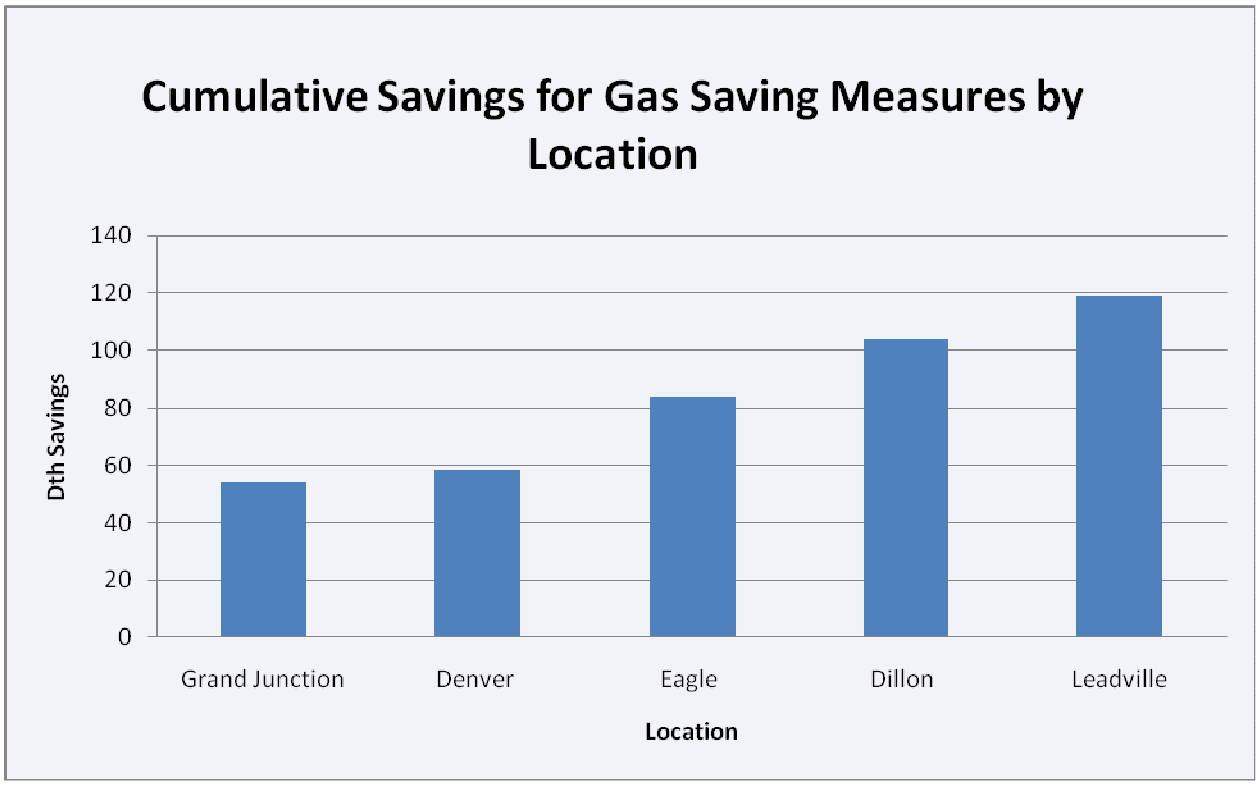
Program savings should be developed once Xcel Energy has decided which assumptions to change. The savings in Table 5, Table 6,Table 7, andTable 8 below illustrate the variations between what Cadmus found in the field and the DSTA deemed savings values, as well as the large savings potentials between various regions. These tables also illustrate the interactive effects between measures. The programs weatherization measures are not additive. For instance, the sum of savings for a high-efficiency furnace and ceiling and wall insulation, shown in Table 5, is 62.7 Dth, but when these measure are modeled together the savings are 58.6 Dth.

Recommendations

Cadmus suggests that Xcel Energy update the DSTA with the recommended values listed in Table 3, as well as with those listed within the body of this report.

- **Consider climate as a component of savings achieved for insulation and high-efficiency furnace measures.** Currently, Xcel Energy uses a singular value for all program measures in all locations. This is appropriate for refrigerators and CFLs, but may not be the best approach for insulation and furnace measures. The current deemed value is specific to the Denver metro area. Xcel Energy can achieve greater accuracy and savings by using climate-specific deemed savings (see Figure 16).

Figure 16. Variation in Gas Savings by Location from REM/Rate Modeling



- **Consider home type as a component of savings achieved through gas measures.** Currently, deemed savings are for site-built homes only. Twenty percent of the residences we visited during the verification site visits were mobile homes. The savings achieved though gas measures for site-built homes are up to 68 percent greater than the gas savings achieved for the same measures in mobile homes.
- **Consider updating assumptions where more current supporting data are available.** Cadmus created a comprehensive list in Table 3 of all the assumptions we verified and used to calculate the recommended savings. We did not limit this to the assumptions in the DSTA.
- **Consider exploring the source of sub-standard insulation practices and perhaps increasing training on insulation practices for installers.** Cadmus found that 35 percent of program ceiling insulation did not meet the final requirement of R-38.
- **Consider including additional AFUE levels for furnaces.** In our interviews with the agencies, they mentioned that the program approved model (of 92 AFUE) sometimes does not fit in the participants' homes, and thus a smaller model might be advised in these cases. Additionally, in the cases where the minimum requirements are not met, Cadmus recommends exploring the reasons for this through the Measurement and Verification process.

Table 5. Cadmus Modeled Gas Savings for Site Built Homes (Dth)

Measure	Baseline Conditions	Measure Conditions	DSTA Value	Denver	Dillon	Eagle	Grand Junction	Leadville
Ceiling Insulation	Ceiling Insulation R-11	Ceiling Insulation R-38	7.9	16.5	29.4	23.8	15.2	33.5
Wall Insulation	Wall Insulation R-0	Wall Insulation R-11	18.7	27.9	49.8	39.6	25.4	57.9
High-Efficiency Furnace	Furnace AFUE 78	Furnace AFUE 92	11.1	18.3	31.9	26.3	16.9	36.0
Ceiling and Wall Insulation	Ceiling Insulation R-11	Ceiling Insulation R-38	N/A	44.5	79.6	63.6	40.8	91.4
	Wall Insulation R-0	Wall Insulation R-11	N/A					
High-Efficiency Furnace and Ceiling Insulation	Ceiling Insulation R-11	Ceiling Insulation R-38	N/A	32.6	57.4	47.0	30.1	65.1
	Furnace AFUE 78	Furnace AFUE 92	N/A					
High-Efficiency Furnace and Wall Insulation	Ceiling Insulation R-11	Ceiling Insulation R-11	N/A	44.2	78.1	63.1	40.6	89.7
	Wall Insulation R-0	Wall Insulation R-11	N/A					
High-Efficiency Furnace, Ceiling and Wall Insulation	Ceiling Insulation R-11	Ceiling Insulation R-38	N/A	58.6	104.0	83.9	54.0	118.9
	Wall Insulation R-0	Wall Insulation R-11	N/A					
	Furnace AFUE 78	Furnace AFUE 92	N/A					

Table 6. Cadmus Modeled Energy Savings for Site Built Homes (kWh)

Measure	Baseline Conditions	Measure Conditions	Denver	Dillon	Eagle	Grand Junction	Leadville
Ceiling	Ceiling Insulation R-11	Ceiling Insulation R-38	3,487.9	6,272.3	5,070.6	3,194.8	7,210.3
Wall	Wall Insulation R-0	Wall Insulation R-11	5,656.8	10,258.5	8,206.8	5,158.6	11,987.8
Ceiling and Wall Insulation	Ceiling Insulation R-11	Ceiling Insulation R-38	9,144.7	16,560.2	13,189.5	8,353.4	19,227.4
	Wall Insulation R-0	Wall Insulation R-11					

Table 7. Cadmus Modeled Demand Savings

Measure	Baseline Conditions	Measure Conditions	DSTA Value	Denver	Dillon	Eagle	Grand Junction	Leadville
Ceiling	Ceiling Insulation R-11	Ceiling Insulation R-38	0.867	1.7	1.8	1.8	1.6	2.0
Wall	Wall Insulation R-0	Wall Insulation R-11	2.052	2.4	2.7	2.7	2.3	3.0
Ceiling and Wall Insulation	Ceiling Insulation R-11	Ceiling Insulation R-38	N/A	4.2	4.6	4.6	3.8	5.0
	Wall Insulation R-0	Wall Insulation R-11						

Table 8. Cadmus Modeled Gas Savings for Mobile Homes (Dth)

Measure	Baseline Conditions	Measure Conditions	DSTA Value	Denver	Dillon	Eagle	Grand Junction	Leadville
Ceiling Insulation	Ceiling Insulation R-11	Ceiling Insulation R-38	7.9	11.5	20.5	16.7	10.7	23.2
	Wall Insulation R-3	Wall Insulation R-3						
	Furnace AFUE 78	Furnace AFUE 78						
High-Efficiency Furnace	Ceiling Insulation R-11	Ceiling Insulation R-11	18.7	13.3	23.5	19.3	12.3	26.3
	Wall Insulation R-3	Wall Insulation R-3						
	Furnace AFUE 78	Furnace AFUE 92						
High-Efficiency Furnace and Ceiling Insulation	Ceiling Insulation R-11	Ceiling Insulation R-38	11.1	19.5	34.5	28.2	18	38.7
	Wall Insulation R-3	Wall Insulation R-3						
	Furnace AFUE 78	Furnace AFUE 92						

The following subsections outline the REM/Rate assumptions provided by Xcel Energy, along with Cadmus' updated assumptions based on our analysis of site visit data.

Home Type

Xcel Energy is currently using savings values for all of Colorado that were developed for one typical home in Denver. A major distinction for all REM/Rate assumptions is that Cadmus is recommending different values for site-built homes vs. mobile homes, where Xcel Energy uses one value for all home types. Ten of the 50 verification sites visits were mobile homes. Despite the relatively low incidence of mobile homes in the general customer population compared to other types of homes, the incidence of mobile homes in this program is presumably higher due to servicing the low-income population. It is important to distinguish mobile homes from site-built homes, because a site-built home can have up to 68 percent greater savings than a mobile home that receives the same measures.

Location

The deemed savings in Xcel Energy's DSTA were calculated for the Denver area only.

Cadmus conducted site visits across Xcel Energy's Colorado territory. We calculated measure savings for each of the following locations: Denver, Dillon, Eagle, Grand Junction, and Leadville. The DOE cost-effectiveness tool only includes data from five Colorado weather stations. The closest approved weather station to Leadville is in Eagle. Cadmus shows in Table 5, Table 6, Table 7, and Table 8 that the savings between Eagle and Leadville are notably different. These differences indicate that using weather data specific to each location could potentially lead to more measures passing the DOE cost-effectiveness criteria.

Conditioned Floor Area

The DSTA specifies 961 square feet as the typical size of a participating home. Cadmus found the average conditioned square footage of site-built homes to be 1,452 square feet.

For mobile homes, REM/Rate uses the length, width, and height of the home in their calculations rather than square footage. The average length, width, and height of the mobile homes we visited were 58.2 feet, 17.7 feet, and 7.6 feet, respectively. A mobile home with these average dimensions is 1,030 square feet, which is seven percent greater than the current DSTA value.

Cadmus used 1,452 square feet and 1,030 square feet, respectively, to model site-built and mobile homes. The current DSTA square footage fell outside of the margin of ± 213 square feet of error for site-built homes and within the margin of error for mobile homes. Cadmus recommends that Xcel Energy consider updating this value in the DSTA for site-built homes, and continue using the current DSTA value for mobile homes.

Number of Bedrooms

The number of bedrooms in the home documented by the DSTA is two.

Our site visits to site-built homes yielded an average of three bedrooms. Most mobile homes had two bedrooms. REM/Rate classifies bedrooms as rooms greater than 70 square feet that have a window, closet, and door.

Foundation Type

The DSTA states that the modeled foundation type is a crawlspace. It is not specified whether the crawlspace is open, enclosed, or conditioned.

Cadmus examined each foundation during our site visits and assigned the most appropriate REM/Rate definition. For mobile homes, Cadmus found the foundation type to be best defined as an open crawlspace. This captures the ventilating properties of mobile home skirts. The majority of site-built homes had an enclosed crawlspace. This is important to define as a model input as the crawlspace specifications influence the model outputs.

Foundation Wall Type

The DSTA states that the crawlspace walls are uninsulated. The majority of foundation walls in our site visits were insulated. The most common insulation we found in the verified crawlspaces was R-11 draped insulation. The foundation wall for all mobile homes were mobile home skirts.

Home Complexity

REM/Rate simplified modeling accounts for the complexity of home design through the number of exterior corners. The number of corners in the DSTA modeled residence is four. During our site visits, Cadmus sketched the footprint of each home and determined the number of corners. Every mobile home we visited had four corners. The typical site-built home also had four corners.

Nominal Ceiling Height

Ceiling height is not included in Xcel Energy's assumptions. The average ceiling height we found for mobile homes was 7.6 feet. The average ceiling height for the site-built homes was 8.2 feet.

Ceiling (Attic) Type

Xcel Energy's COSFW Program specifies that homes receiving ceiling insulation must increase the R-value from 19 or less, to R-38, and assumes that the existing insulation levels are R-11. While on-site, Cadmus verified whether insulation was installed and its final R-value. Twenty-three of the 50 sites we visited received ceiling insulation. Of those 23, 15 met the R-38 requirement. The eight homes that did not meet the program requirements had ceiling R-values ranging from 20 to 36. These eight homes were also distributed evenly across the service territory, indicating the problem was not limited narrowly to a specific installer. Cadmus used the program requirement of R-38 to determine the recommended savings, because residents did not control the amount of insulation that contractors installed in their attic.

In addition to the physical inspection, Cadmus used thermographic imaging to inspect the quality of installation, and assigned a RESNET insulation grade of I, II, or III as provided in the REM/Rate models. Insulation grades are based on anomaly areas: those detected with the infrared camera that differ by 4° F or more from the expected temperature distribution. Grade I is defined as having less than 0.05 percent of the total insulation area with anomalies, and can only be assigned with a visual inspection. Grade II is defined as having anomalies in 0.05 to two percent of the area. Grade III is defined as anomalies taking between two and five percent of the area. REM/Rate does not provide an option for fractional grades; they must be entered as Grade

I, II, or III. Figure 15 illustrates ceiling and wall insulation anomalies in the corner of a site-built home.

The three mobile homes in the sample that received ceiling insulation all received a Grade II, and Cadmus used Grade II in the REM/Rate to model this measure. For mobile homes that did not receive ceiling insulation, five received a Grade III and two received a Grade II. Cadmus used Grade II for all the applicable models of mobile homes that received insulation, and used the default mobile home insulation REM/Rate input for the applicable models of mobile homes that did not receive insulation.

Of the 20 site-built homes that received attic insulation, four received Grade III and 16 received Grade II. Cadmus used Grade II for these models. Of the 20 homes that did not receive ceiling insulation, eight received Grade III and 12 received Grade II. Cadmus used Grade II to model site-built homes that did not receive ceiling insulation.

Above-Grade Wall Type

Xcel Energy's COSFW Program specifies that homes receiving wall insulation must not have any existing wall insulation, and the installed insulation cannot exceed R-11. To model the baseline for site-built homes that received wall insulation, Cadmus used an R-value of 4.37 (we based this value off an *in-situ* study showing that empty wall cavities have an R-value of 4.37).[4] For homes not eligible to receive insulation, DSTA assumes that the existing R-value is 3.00. This value is found in existing wall insulation of vintage homes built between 1960 and 1970,[5] which aligns with the average vintage of 1961 verified for site-built homes.

Physical inspection of wall insulation is not feasible once a residence is fully built. Cadmus used infrared cameras to take thermographic images of each residence exterior and assigned a RESNET insulation grade of II or III (with the same definitions as ceiling grading explained above). Since Grade I can only be given with a visual inspection, Cadmus did not assign a Grade I to any wall inspection.

None of the mobile homes in our verification sample received wall insulation. Four mobile homes with existing insulation received Grade III, and six received Grade II. Cadmus used Grade II for wall insulation in every mobile home model. Cadmus used the default REM/Rate input to model mobile home walls.

Fifteen site-built homes in the sample received wall insulation. Seven of those received Grade III wall insulation and eight received Grade II. Since insulation grade cannot be adjusted into fractions in REM/Rate, and the instances of both grades are very close, Cadmus determined that Grade III was the most appropriate for the models. Our methodology for the thermographic verification was to document anomalies rather than adequacies. Therefore, it is more probable that anomalies that would have resulted in a Grade III went undocumented.

Foundation Floor Type

The DSTA does not state if the foundation floor is insulated or not. Cadmus used the REM/Rate default for a mobile home belly of R-9.3 for the foundation floor type. For site-built homes,

[4] Doherty, Tom. *Residential Wall and Ceiling Construction – R-values*. The Cadmus Group, Inc., 2011.

[5] MGE Responsible Energy: http://www.mge.com/images/PDF/Brochures/Residential/ExteriorWallInsulation.pdf

Cadmus modeled the homes with uninsulated foundation floors. During our site visits, 33 of the 40 site-built home foundation floors were uninsulated.

Door Type

The most common type of door Cadmus verified at mobile homes was a 1-3/4 inch metal clad foam. REM/Rate assigned this type of door a value of R-1.7. We used this door type in all of the mobile home models.

Cadmus verified that the most common door at site-built homes was also a 1-3/4 inch metal clad foam. We used this door type for all of site-built home REM/Rate models. Cadmus recommends including door type in the DSTA.

Infiltration Rate

The DSTA assumes 0.8 air changes per hour (ACH). Cadmus determined the home infiltration rates using the GEO pre and post data. The GEO provided Cadmus with data collected on-site for the same weatherization program participants. They provided data for 42 of the 50 sites Cadmus verified. This data included air infiltration measurements for pre and post air sealing measures. Cadmus used the post measurements to determine the infiltration rate for all of the models. The GEO reported infiltration rates in CFM 50, which is the cubic feet per minute of measured air leakage when a house is pressurized to 50 Pascals.

Cadmus determined natural air changes per hour for each verified site using the following equations:

$$ACH_{50} = \frac{CFM_{50} * 60}{Building\ Cubic\ Feet} \quad (1)$$

$$ACH_{Natural} = \frac{ACH_{50}}{20} \quad (2)$$

Equation 1 is the Minneapolis Blower Door™ standard equation and Equation 2 is the Persily average infiltration rate equation.

Cadmus calculated each home's cubic feet using the verified square footage and ceiling height for each location with CFM 50 results. The average natural air changes per hour we determined for the mobile homes was 0.67, and was 0.66 for the site-built homes.

The margin of error for both of the infiltration rates captured the current DSTA value. Therefore, the continued use of 0.8 is appropriate.

Window Properties

The DSTA states that the window area used to determine the deemed savings was 15 percent of the conditioned floor area, which is 144.15 in the current DSTA. The DSTA defined the U-value and solar heat gain coefficient (SHGC) as 1.27 and 0.75, respectively. It also states that no shading factors were used, as shading is specific to each location. A two foot overhang was assumed for each window.

Many of the residences we visited had several different types of windows. We captured the widow type and area of each window during site visits. Cadmus developed and applied a standard window U-value, a SHGC, and window area to each home in all of our models. We

divided the average total window area for site-built homes and mobile homes by four, and assigned that value to each side of the home.

Cadmus found the average window area to be 108.2 sqft for mobile homes with a ±17.9 sqft and 217.8 ± 20 sqft for site built homes. Cadmus recommends that Xcel Energy consider updating the window area to 108.2 sqft for mobile homes. Since the current DSTA is using 144.15 sqft to model homes and it is within the margin of error its continued use is warranted.

Cadmus determined the standard U-value and SHGC with the following process.

1. We verified the following nine window types during our site visits: single pane wood frame, single pane wood frame with storm, single pane metal frame, single pane metal frame with storm, double pane wood frame, double pane wood frame with storm, double pane metal, double pane metal frame with storm, and double pane vinyl frame.
2. Cadmus determined the total area for each window type, and then assigned the default REM/Rate U-value and SHGC to each window type. The weighted average of U-value and SHGC we used are based on the area of each window type.
3. We used the window area of 27.05 square feet for each of the four sides of the mobile home model. The U-value is 0.86 and the SHGC is 0.72.
4. The average window area for each side of site-built homes was 39.2 square feet. The U-value and SHGC are 0.75 and 0.67, respectively.
5. The current DSTA values for window U-value and SHGC fell outside of the margin of error for the Cadmus-determined values. Cadmus recommends that Xcel Energy consider updating the U-value and SHGC in the DSTA. The margin of error of the average window area for verified mobile homes did not include the DSTA value. Cadmus recommends updating this DSTA value. For site-built homes, the DSTA window area was included in the margin of error, so the continued use of those DSTA values is appropriate.

Cadmus agrees with the REM/Rate model reasoning for not including shading as a variable in the savings calculations. In addition to shading being different for each residence, each window's interior shading can easily be changed by the occupant throughout the day.

Cadmus did not use the two foot overhang for windows, because the effect this has on annual heating consumption is dependent on the distance from the top and bottom of the window. The DSTA does not define those distances. Cadmus found too many sources of discrepancy to develop typical values for the distance from the top and bottom of windows, since there were often several sizes and arrangements of windows at each residence. Therefore, Cadmus did not include an overhang or distances from the top and bottom of the window in the REM/Rate modeling.

Furnace Properties

Cadmus recorded the furnace make, model, serial number, and output kBtuh at each residence we visited, excluding homes without a furnace or where it was inaccessible. Cadmus then used the AHRI Certification Directory[6] to confirm the AFUE of each furnace.

Cadmus found that the average output capacity for mobile homes we visited was 57.9 kBtuh, and for site-built homes was 65.9 kBtuh. Cadmus assumed that furnaces replaced by the program had the same output capacity as the furnaces removed, which would meet the design load capacity of each home. Fourteen of the 50 sites we visited received new furnaces under the program. Cadmus was only able to verify the AFUE for 13 of those furnaces, because one furnace was located in an inaccessible attic. Of those 13, eight met or exceeded the minimum requirement of 92 AFUE ratings. The five furnaces that did not meet the program requirements were all 90 AFUE. Cadmus used 92 AFUE furnaces to determine furnace savings, as this is the program requirement. In our interviews with the agencies they mentioned that the program approved model (of 92 AFUE) sometimes does not fit in the participants' homes, and thus a smaller model might be advised in these cases. Thus, Cadmus recommends considering including additional AFUE levels for furnaces. Additionally, in the cases where the minimum requirements are not met, Cadmus recommends exploring the reasons for this through the Measurement and Verification process.

Duct System Properties

The DSTA assumes that the ductwork is in the crawlspace, with an insulation value of R-4 and leakage of 25 percent. During the verification site visits, Cadmus determined the location of the majority of the duct systems.

Post site visits, Cadmus examining pictures taken at each site and found that the majority of duct work in site-built homes was not insulated. Duct work in mobile homes was typically encased in the belly insulation. Since the duct work was not directly visible, Cadmus modeled the ductwork in REM/Rate as being located in the open crawlspace with R-9.3 insulation (the REM/Rate default insulation value of the mobile home belly).

Cadmus did not conduct duct leakage testing during the verification site visits. Therefore, Cadmus used the DSTA assumption of 25 percent duct leakage for the REM/Rate modeling. We found this to be an appropriate assumption: when we input 25 percent duct leakage into REM/Rate compared to the REM/Rate default duct leakage, the modeled annual heating consumption was less than 10 percent different.

Appliance Properties

Cadmus verified whether each residence had a dishwasher and a cooling system, and the fuel type of the stove and dryer. We modeled the fuel and appliances variations and found that they had no impact on the annual heating consumption of the homes. Xcel Energy does not offer low-income cooling savings, so we did not model homes with cooling systems, and therefore did not review annual cooling consumption.

During site visits, Cadmus verified the assumptions and methodology used to determine the recommended savings for refrigerators and CFLs. Those used in the DSTA deemed savings were

[6] http://www.ahridirectory.org/ahridirectory/pages/home.aspx

well documented and generally sound. Table 9 documents updated assumption values based on our findings during the verification site visits.

Table 9. Cadmus Recommended Savings for Refrigerators and CFL Measures

Measure	kWh	kW
Refrigerators	437.4	0.09
CFLs - Mobile Home	483	0.04
CFLs - Site-Built Home	648	0.05

Refrigerators and CFLs

Xcel Energy's COSFW Program stipulates that in order for a customer to qualify for refrigerator replacement, their existing refrigerator must have been manufactured before 2001.

The DSTA uses federal standards from 1993 to 2001, with an adjusted volume between 23.47 and 23.66 cubic feet, and a 1.037 percent degradation, to determine the baseline consumption of antiquated refrigerators based on the year of manufacture. DSTA uses a survival function to estimate the number of refrigerators still in use based on the vintage, then uses that survival function to determine the weighted baseline consumption for all qualifying refrigerators. Cadmus found this methodology to be robust.

Based on the data we collected during verification site visits and *in-situ* studies, we recommend updated assumptions for refrigerator adjusted volume and degradation factor. For residences that received new refrigerators, the replaced refrigerator specifications such as age and size were not recorded. Therefore, Cadmus assumes that the size of the replaced refrigerator is comparable to the new refrigerator. From the site visit data, we calculated the average adjusted volume as 21.58 cubic feet using an ENERGY STAR-qualified product lists. Cadmus has determined from *in-situ* studies that an appropriate value for refrigerators degradation factor is 1.25 percent annually.[7] Cadmus used the same methodology, along with survival rate and updated assumptions, to calculate the recommended year one deemed savings. The DSTA current adjusted volume falls outside of the margin of ±1.53 cubic feet of error for the average size of the verified units. Cadmus advises that this value be reviewed for updating.

The DSTA does not specifically state refrigerator run time or a coincidence factor that were used to determine refrigerator demand savings. Cadmus determined from the deemed savings and using the recommended Efficiency Vermont TRM[8] coincidence factor of 1 that the annual runtime used in the DSTA was 7,300 hours. Cadmus found this number to be on the high side and used the 4,818 refrigerator operating hours-per-year from Xcel Energy's Minnesota Home Energy Savings Program DSTA to determine the recommended demand savings of 0.09 kW.

CFLs

The Filing states that the CFL measure replaces 16 incandescent lamps with lumen-equivalent ENERGY STAR CFLs. Xcel Energy determined the average baseline of replaced incandescent lamps to be 65.25 Watts and the average CFL to be 19 Watts. Cadmus found Xcel Energy's

[7] http://www.nwcouncil.org/energy/rtf/meetings/2010/0629/Refrigerator Decommissioning Update_rev2.ppt (see slide 13).

[8] Efficiency Vermont. *Technical Reference User Manual*. N.p.: 2010.

methodology for CFLs and comparable incandescent wattage and the saturation of each CFL wattage on the market to be appropriate.

Xcel Energy used 2.78 hours of operation per lamp per day to determine an annual energy savings of 752 kWh. From the 2010 Colorado Lighting Evaluation report[9] we prepared for Xcel Energy, the recommended hours-of-use for CFLs is 2.3 hours per day. However, Cadmus accepts the use of 2.78 hours of operation per day due to the unknown use and conditions in low-income households.

The DSTA defines the coincidence factor as eight percent. This coincidence factor is the same as the value recommended in the aforementioned report, and Cadmus recommends its continued use. The DSTA states that using a coincidence factor of eight percent produces demand savings results of 0.06 kW. However, the DSTA claims the full demand reduction of 0.74 kW.

Thirty-two of the homes we visited received program CFLs. During the verification site visits, Cadmus found that the majority of homes did not have 16 CFLs installed. The average number of CFLs installed in mobile homes was 10.3, and the average for site-built homes was 13.8. The average site-built home we visited had 29.5 sockets and the average mobile home had 21.75 sockets. Cadmus did not inventory the quantities or types of bulbs that residents had in storage.

The DSTA value of 16 bulbs falls outside of the calculated margin of ±2.9 error for mobile homes, but is inside the margin for site-built homes. Cadmus recommends using 10.3 CFLs for mobile homes and the DSTA value of 16 CFLs for site-built homes to determine the electric and demand savings for this measure. The DSTA savings for site-built homes should stay the same, and our recommended savings for mobile homes is 484 kWh. Using an eight percent coincidence factor, the resulting recommended customer billed demand savings are 0.04 kW and 0.06 kW for mobile homes and site-built homes, respectively.

[9] The Cadmus Group, Inc. *Colorado Home Lighting Program Process and Impact Evaluation Report.* Prepared for Xcel Energy. 2010.

8. Peer Utility Benchmarking (Task 6)

Cadmus completed a benchmarking study to compare the COSFW Program design elements to those of other income-eligible weatherization programs across the United States. Table 10 shows several comparison utilities that offer similar programs in Iowa, Massachusetts, New Hampshire, Ohio, and Pennsylvania.

Table 10. Comparison Income-Eligible Weatherization Programs

Program State	Utility(ies)
Iowa	Interstate Power and Light Company MidAmerican Energy Black Hills Energy
Massachusetts	National Grid NSTAR Unitil Cape Light Compact Western Massachusetts Electric Company Bay State Gas Berkshire Gas Columbia Gas New England Gas
New Hampshire	Public Service of New Hampshire New Hampshire Electric Cooperative Keyspan Northern Utilities
Ohio	American Electric Power Columbia Gas Dominion Vectren Energy Delivery of Ohio Cinergy
Pennsylvania	PECO

The key program design elements we compared were:

- Implementation,
- Customer outreach,
- Eligibility requirements,
- Incentives, and
- Program success.

Findings

Xcel Energy's COSFW Program is comparable to the other programs we researched in this benchmarking study. All of the programs' weatherization services are delivered through a network of local community action agencies within each utility's service territory. The eligibility requirements for all programs are within the same range. All of the utilities in this benchmarking

study offer a broader variety of eligible program measures per home than Xcel Energy; however, the COSFW Program measures funded by Xcel Energy are included in the measures offered by all of the programs compared. Each of the evaluated programs also provide energy education to their customers as part of the program, although some utilities offer more extensive energy education than others. These findings are discussed in more detail below.

Implementation

Similar to Xcel Energy's program, the Ohio and Iowa utility-funded programs are implemented by a state office. The Ohio Department of Development, Office of Energy Efficiency (OEE) implements the program for the Ohio utilities. The Department of Human Rights, Division of Community Action Agencies administers and delivers program services on behalf of the Iowa utilities. While all of the compared utility programs are delivered in conjunction with their state's government-funded weatherization program, not every utility uses a state office as their program implementer. All of the programs experience some type of state and/or federal government involvement, yet some require more oversight than others.

All of the compared programs leverage the resources of local community action agencies to provide awareness, verify eligibility, and implement services on behalf of the sponsoring utilities. Utility funds are allocated to local community action agencies to implement the programs in their designated geographic areas. The utility-funded weatherization programs in New Hampshire and Iowa are fully administered and implemented by the network of community action agencies within their service territories.

Many utilities have found that hiring third-party implementers is an effective means of obtaining administrative support for their low-income programs. PECO's program is implemented by a third-party administrator, CMC Energy Services (CMC), who then subcontracts the local community agencies to deliver weatherization services.

The Massachusetts utility program is a standardized yet separate effort; each sponsoring utility chooses a method for administering their respective low-income weatherization programs. National Grid, NSTAR, Unitil, and Columbia Gas each chose one of the larger Community Action Program (CAP) agencies to act as their lead administering agency. These CAP agencies are similar to local low-income assistance agencies and work in each state across the country. These larger CAP vendors leverage program budget to the smaller, local CAP agencies on behalf of their contracting utility.

Berkshire Gas chose to hire the Center for Ecological Technology, another third-party implementer, to administer their program and work with the local CAP agencies to deliver the program. Western Massachusetts Electric Company, New England Gas, and Cape Light Compact each contract directly with the local CAP agencies to implement their programs. Table 11 describes each program's implementation structure.

Table 11. Implementation Structures of Compared Programs

State	Implementers	Local Agency Involvement	State/Federal Involvement
Colorado	The program is managed in partnership with the Colorado Governor's Energy Office (GEO)	Xcel Energy and the GEO contract with eight agencies to deliver program services to local residents.	The program is run in partnership with the GEO. The GEO administers the program in conjunction with eight local agencies.
Iowa	The Iowa Department of Human Rights, Division of Community Action Agencies administers and implements program services.	A network of over 17 agencies implement the program and provide weatherization services.	The Iowa Department of Human Rights, Division of Community Action Agencies oversees the progress of the program.
Massachusetts	Five lead vendors administer the program and manage the local CAP agencies.	Massachusetts Association for Community Action, a network of over 20 local agencies, acts as the face of the program and implements program services. They contract with weatherization professionals to install program measures.	The Massachusetts Department of Housing and Community Development oversees the program. The state-appointed Low-Income Energy Affordability Network acts as the liaison between low-income customers and the sponsoring utilities.
New Hampshire	The program is delivered through a network of six local community action agencies.	Six local weatherization agencies deliver the program on behalf of the electric utilities. Four of the agencies implement the program for the gas utilities.	All utility-funded audits are performed by auditors who have been certified by the NH Office of Energy and Planning. The electric utilities require the use of DOE-approved computerized energy audit software (e.g., NEAT) during their in-home audits.
Ohio	The OEE was created within the Ohio Department of Development (ODOD) to oversee the implementation of the program.	The utilities rely on a network of 58 community and local government organizations to deliver program services.	The OEE was created within the ODOD to oversee the implementation of the program.
Pennsylvania	PECO contracts with CMC (a for-profit company) to administer their program. CMC has five subcontractors that install major program measures.	CMC recruits customers who are directly referred from external organizations, including social and governmental agencies.	The Pennsylvania PUC requires that all electric and gas utilities in the state offer a Low-Income Usage Reduction Program to their customers.

Customer Outreach

Low-income program marketing is minimal nationwide due to oversubscription of most programs. Many programs have wait lists for participation, on occasion requiring customers to wait over one year for services, and therefore do not find it necessary to fund additional outreach. PECO's program in Pennsylvania, however, does require that their implementer's customer service representatives contact potential program participants by telephone to explain program services, obtain customer information, and confirm or determine eligibility. The implementer must attempt to make this contact a minimum of three times by telephone and once by mail over a 30-day period.

Similarly, the evaluated utilities in Massachusetts utilize both their call centers and their implementing CAP agencies to help promote the program. If a customer calls their utility call center with concerns about the cost of their bill, the call center connects the customer with their local CAP for additional assistance. The CAP agencies then refer customers who are receiving government fuel assistance to the weatherization program.

All of the compared utilities maintain a page on their Website that provides minimal program details. Each respective Website directs customers to their local agencies to learn about program details and income requirements.

Eligibility Requirements

The COSFW Program has similar eligibility requirements to the compared programs. All of the programs that use the Federal Poverty Guidelines for income-eligibility requirements range between 150 and 200 percent of the federal poverty level. Massachusetts' utility-funded program is the only program compared that uses the state median income as the eligibility determinant, requiring participants to fall at or below 60 percent of the state median income. Similar to Xcel Energy's eligibility stipulation regarding participants who qualify for DOE's Weatherization Assistance Program, Iowa's program also has a condition that any recipients of Supplemental Security Income (SSI) or Family Investment Program (FIP) assistance are eligible for their weatherization program, regardless of income. Table 12 illustrates the specific eligibility requirements by program.

Table 12. Eligibility Requirements for Participants

State	Income Qualifications	Additional Qualifications
Colorado	< 150% of the Federal Poverty Level	When a new calendar year begins, customers on the wait list that have not yet participated in the program must reapply for LEAP funding in order to qualify for the program.
Iowa	< 200% of the Federal Poverty Level	Recipients of SSI or FIP assistance are eligible (regardless of income).
Massachusetts	< 60% of the state median income	N/A
New Hampshire	< 185% of the Federal Poverty Level	Applicants need to re-certify eligibility if more than 12 months have elapsed since initially signing up.
Ohio	< 150% of the Federal Poverty Level	N/A
Pennsylvania	< 150% of the Federal Poverty Level	Household usage levels must exceed: • 600 kWh per month for electric baseload, • 1,400 kWh per month for electric heat, OR • 100 ccf per month for gas heat.
		Special needs residential customers must: • Be in arrears • Have an annual household income between 151% and 200% of the Federal Poverty Level.

All of the compared programs allow renters and/or occupants of multifamily buildings to participate in their weatherization programs, with restrictions. For example, the New Hampshire program does not provide heating system replacements to renting participants because of the

New Hampshire Landlord-Tenant law,[10] which requires that landlords provide working and safe heat to tenants.

Incentives

Program Measures

The COSFW Program provides both natural gas and electric saving measures. The compared programs each offer a combination of weatherization measures that accrue electric and gas savings in each participating home. Table 13 depicts a comparison of each program's full measures list.

All of the compared programs, including Xcel Energy's, offer participants insulation and furnace and/or refrigerator replacements. Unlike Xcel Energy, the compared programs all offer additional measures to achieve greater savings per home. Xcel Energy provides some of these additional measures in other programs such as their Low Income Energy Saving Kits. These additional measures include air sealing and hot water measures (e.g., low-flow showerheads and faucet aerators).

Xcel Energy's approved list of measures was designed to compliment that of the Colorado Weatherization Assistance Program. In most cases, Xcel Energy's implementer, the GEO, covers any remaining measures needed by a low-income customer, including those measures that meet the DOE's health and safety measures, such as grounded outlets for refrigerators.

Xcel Energy's approach to leveraging funding is in contrast to some of the compared programs. In Massachusetts, the program sponsors' approved measures list almost exactly matches the state's approved measures list as applied to the state-funded Massachusetts Weatherization Assistance Program. The Massachusetts utilities rely heavily on their implementing local community action agencies to leverage their funding appropriately to help their low-income customers get as many weatherization services as needed and to appropriately use their full budgets..

Xcel Energy's program has a heavy emphasis on electric savings in low-income customer homes. Xcel Energy's COSFW Program and each of the programs compared, excluding Ohio's utility-funded program, provide CFLs to program homes. Xcel Energy's program provides significantly more CFLs per home than any of the other programs. The comparison program that offers the largest number of CFLs is in Iowa, which provided an average of 10 CFLs per homes. The other compared programs usually only provide the number of bulbs that can be installed immediately.

[10] http://secure.uslegalforms.com/lawsummary/NH/NH-864LT.htm

Table 13. Program Offerings

Program Measures	CO (XE)	IA	MA	NH	OH	PA
Air conditioner replacement			x			x
Air sealing		x	x	x	x	x
Attic insulation	x	x	x		x	
Band joist insulation		x				
CFLs	x	x	x	x		x
Crawlspace insulation		x				
Duct insulation			x		x	
Faucet aerators		x	x	x		x
Floor insulation		x			x	
Freezer recycling (secondary freezer)		x				
Freezer replacement		x	x			
Furnace replacement	x	x	x	x	x	x
Furnace tune-up and repair		x	x		x	x
Heat pump replacement		x				
Heating system ventilation		x				
Insulation (general)				x		x
Major weatherization repairs		x	x			
Pipe insulation/pipe wrap		x	x			x
Programmable thermostat		x		x		
Refrigerator recycling (secondary fridge)		x				
Refrigerator replacement	x	x	x	x		x
Showerheads		x	x	x		x
Smoke detectors						x
Wall insulation	x	x	x		x	
Water heater insulation					x	x
Water heater replacement		x				
Water heater timer installation						x
Water heater ventilation		x				

Energy Education

All of the compared programs provide some type of educational component to their participants. Most of the programs' educational component consists of:

- Client assessment and education
- Distribution of conservation education materials
- Measure-specific energy education
- Energy saving tips

The COSFW Program emphasizes energy education as a way to help customers decrease their daily energy usage. PECO's program focuses heavily on educating their customers about energy savings. PECO reported surprisingly high savings for program households that only received

CFLs: savings among these customers averaged 507 kWh, higher than the 274 kWh expected savings from installing four CFL bulbs in a home. Customer survey research that was conducted as part of PECO's Universal Service Fund evaluation[11] confirmed that the increased savings are due to the extensive education process that occurs during a 30-minute session with the auditor, along with the reinforcement that occurs through follow-up letters and phone calls provided by implementation staff.

Program Success

Cadmus reviewed four impact evaluation reports for Iowa, New Hampshire, Ohio, and Pennsylvania.[12] Each of these reports presented evaluation findings from previous program years. PECO's program had the highest participation and costs to date. However, Columbia Gas in Ohio achieved the highest annual therm savings per home through their program. Table 14 illustrates the full analysis of annual savings, participation, and associated costs for each program.

[11] APPRISE Incorporated. *PECO Energy Universal Services Program Final Evaluation Report*. 2006. www.puc.state.pa.us

[12] The Massachusetts low-income program impact evaluation is currently in progress.

Table 14. Benchmarking of Participation, Program Costs, and Annual Savings

State	Utility	Evaluated Year(s)	Number of Homes Served#	Program Costs##	Estimated Program Cost/ Home	Annual Electric (kWh) Savings/ Home	Annual Fuel (Therm) Savings/ Home
Colorado[13]	Xcel Energy	2010	5,267	$3,123,084	$593	1,711	182
Iowa	Interstate Power and Light Company	2009	883	$1,809,190	$2,049	1,004	219
	MidAmerican Energy		611	$1,719,118	$2,931	998	202
	Black Hills Energy		178	$409,239	$2,299	N/A	149
New Hampshire	Public Service of New Hampshire	2006	577	$836,073	$1,449	872	N/A*
	New Hampshire Electric Cooperative						
	Keyspan						
	Northern Utilities						
Ohio	American Electric Power	2003	213	N/A**	N/A**	1,473	N/A
	Columbia Gas		681	$1,448,669	$2,127	N/A	282
	Dominion		748	$624,266	$835	N/A	264
	Vectren Energy Delivery of Ohio		108	N/A**	N/A**	N/A	231
	Cinergy		88	N/A**	N/A**	N/A	241
Pennsylvania (Electric Heat Program)	PECO	2008	143	$313,225	$2,190	2,172	N/A
Pennsylvania (Gas Heat Program)			1,140	$2,273,749	$1,995	530	105

\# Number of homes served during the evaluation period.
Funding spent during the evaluation period.
* Gas savings were not reported for this utility-funded program.
** The full data request was not fulfilled by all evaluated utilities; therefore, we could not provide all the information.

Recommendations

The following recommendations are also provided in the executive summary of this report.

- **Continue to use a third-party implementer to run the program**, whether that is the GEO or a CAP. Because there are multiple program actors dispersed around the state, use of a third-party implementer has proven to be an effective method of streamlining the program delivery for Xcel Energy.

[13]. *2010 Demand Side Management Annual Status Report, Electric and Natural Gas,* April 1, 2011, Public Service Company of Colorado Docket No. 08A-366EG.

- Should Xcel Energy continue to work with the GEO as an implementer, and should the GEO continue to make frequent policy changes, **consider working with the GEO to create a solution for on-the-ground field staff compliance** such as a monthly update document or conference call describing any new changes.
- **Consider adding measures to the program** such as hot water measures and air sealing measures.
- **Consider expanding the insulation options** that qualify for the program. Currently, to participate in the program customers cannot have existing wall insulation, which rules out customers who have very low levels of insulation.

Appendix A: Data Collection Instruments

Xcel Energy's Colorado Low Income Home Weatherization Program Participant Survey

Respondent Name: _____
Address: _____
City/State/ZIP: _____
Phone: _____
Interview date: _____ Interviewer initials: _____
Electric Provider: _____ Gas Provider: _____
ID: _____

A. Introduction

A1. Hello, my name is _____, from The Cadmus Group, and I'm calling on behalf of [the weatherization program provided by [Local Agency]. May I speak with [INSERT PARTICIPANT'S NAME]?

1. Yes
2. No **[SKIP TO A4]**

A2. Our records indicate that you have participated, or are currently participating, in the Weatherization Program. This is the Program that would have provided you with any of the following: furnace upgrade, wall or ceiling insulation, replaced your refrigerator, and/or installed Compact Fluorescent Light bulbs in your home. Is that correct?

1. Yes
2. No **[THANK AND TERMINATE]**
-99 Refused **[THANK AND TERMINATE]**

[EMPHASIZE THAT]:
"Your participation in this study is important so that the program can include your perspective in how these services are provided for other participants."

[IF NEEDED]:
This survey is for research purposes only and this is not a marketing call. This is the primary way for home owners to provide input into the program. Your responses will remain confidential.

RESPONSE TO CUSTOMER QUESTIONS
Timing: This survey should take about 15minutes of your time. Is this a good time for us to speak with you? (IF NOT, SET UP CALL BACK APPOINTMENT OR OFFER TO LET THEM CALL US BACK AT XXX-XXX-XXXX)

(**Who are you with:** I'm with The Cadmus Group, an independent research firm that has been contracted to conduct this research study. I am calling to learn about your experience in the Weatherization Program.

(**Sales concern:** I am not selling anything; we would simply like to learn about your experience with the Weatherization Program. Your responses will be kept confidential. If you would like to talk with someone about this study, feel free to call XXXXXXXX at XXX-XXX-XXXX)

(**Why are you conducting this study:** Studies like this help improve the services provided by the weatherization program and verify that you received the all the services you were eligible for.)

A3. I'm not selling anything; I just want to ask you some questions about your experience and satisfaction with your participation in the Weatherization Program. Your comments will be used to make improvements to the Program. Do you have 15 minutes to answer some questions?

1.	Yes	**[SKIP TO A5]**
2.	No, new respondent coming to phone	**[REINTRODUCE] [GO BACK TO A2]**
3.	No, respondent not available	
-99	Refused	**[THANK AND TERMINATE]**

A4. Is there a more convenient time I could call you back?

1.	Available now	**[GO BACK TO A2]**
2.	Not available	**[ARRANGE CALLBACK]**
3.	No	**[THANK AND TERMINATE]**
-98	Don't know	**[THANK AND TERMINATE]**
-99	Refused	**[THANK AND TERMINATE]**

A5. Were you involved in the decision to participate in the Home Weatherization Program?

1.	Yes	
2.	No	**[ASK FOR DECISION-MAKER, REINTRODUCE] [GO BACK TO A2]**
-98.	Don't know	**[THANK AND TERMINATE]**
-99	REFUSED	**[THANK AND TERMINATE]**

B. Awareness & Participation

B1. How did you FIRST find out about the Weatherization Program? DO NOT READ

1. Outreach specialist called me
2. Outreach specialist met with me
3. Xcel Energy website
4. Marketing from Xcel Energy (Specify:_____)
5. Friend/family member
6. Landlord
7. Other (Specify:_____)

-98 DON'T KNOW
-99 REFUSED

B2. What was the main reason you decided to participate in the Program? DO NOT READ

1. It was free
2. Uncomfortable home (e.g., drafty/leaky)
3. High utility bills
4. Health of family
5. Landlord suggested
6. Environmental reasons
7. I needed ceiling insulation
8. I needed wall insulation
9. I needed a furnace upgrade
10. I needed to replace my refrigerator
11. I needed some light bulbs / CFLs
12. Other (Specify: _____)

-98 Don't know
-99 Refused

B3. Before this call, were you aware that Xcel Energy was a sponsor of this program?

1. Yes
2. No **[SKIP TO B5]**

-98 Don't know **[SKIP TO B5]**
-99 Refused **[SKIP TO B5]**

B4. How did you first learn about Xcel Energy's role in the program? DO NOT READ Single choice

1. Brochure from agency
2. Television ad/promotion
3. Bus shelter ad
4. Print advertisement
5. Installer's educational material
6. Other (Specify: _____)

-98 Don't know
-99 Refused

B5. **If you were** looking for information about how to save energy, what sources would you seek out? DO NOT READ **[INDICATE ALL THAT APPLY]**

1. Friends/ family members/ coworkers
2. Television program
3. Newspaper/ magazines
4. Book/Library
5. Environmental organizations
6. Utility bill insert
7. Utility newsletter
8. Online/website (which ones? _____)
9. Community agency/organization
10. Community/church event
11. Phone book/yellow pages
12. Other (Specify: _____)

-98 DON'T KNOW

-99 REFUSED

B6. What energy saving equipment or upgrades were installed in your home as a part of the Home Weatherization Program? **DO NOT READ [INDICATE ALL THAT APPLY]**

1. Ceiling Insulation
2. Wall insulation
3. Furnace upgrade
4. Refrigerator replacement
5. Compact Fluorescent Light bulbs
6. Other (Specify :_____)

-98 DON'T KNOW
-99 REFUSED

B7. **[IF IN SAMPLE <Refrigerator Replacement= Y>]How many refrigerators do you own?**

1. Enter number _____

-98 DON'T KNOW
-99 REFUSED

B8. **[IF B7=1]** Did the agency staff person offer to recycle any additional refrigerators?

1. Yes
2. No

-98 DON'T KNOW
-99 REFUSED

B9. **[IF B8= 1]** Did you recycle it at this time or if not, what was your main reason for deciding to keep your second refrigerator? **[RECORD RESPONSE, 1, Recycled it at this time -98= DON'T KNOW, -99= REFUSED]**

B10. **[IF IN SAMPLE <CFL Lighting Package= Y>]** How many compact florescent lights, otherwise known as CFLs were installed in your home during the visit? [**IF NEEDED:** These are "energy saving" light bulbs that usually do not look like regular bulbs. The most common type of CFL is made with a glass tube bent into a spiral, resembling soft-serve ice cream, and it fits in a regular light bulb socket.] **[RECORD RESPONSE, -98= DON'T KNOW, -99= REFUSED]**

B11. **[IF B10 >0]** How many of the CFLs you received from the program are still installed? **[RECORD RESPONSE, -98= DON'T KNOW, -99= REFUSED]**

B12. **[IF B10 >0]** How many of the CFLs you were provided with are currently not installed but kept in storage? **[RECORD RESPONSE, -98= DON'T KNOW, -99= REFUSED]**

B13. **[IF B10 >B11]** Did you replace any of the CFLs that were installed with different ones?

1. Yes
2. No
-98 DON'T KNOW
-99 REFUSED

B14. **[IF B13 =1]** Which type of bulb did you use to replace them/it with? **[PROMPT IF NEEDED]**

1. CFLs (RECORD HOW MANY: _____)
2. Incandescent bulbs (RECORD HOW MANY: _____)
-98 DON'T KNOW
-99 REFUSED

C. Satisfaction

Now I have a few questions about your satisfaction with the Weatherization Program and the products that you received. Here, we are talking more about the products' performance and quality. Later, I will ask about the installer and their workmanship and customer service, OK?

C1. On a scale from 0-10, where 0 means not at all satisfied and 10 means completely satisfied, please rate your overall satisfaction with the Home Weatherization Program you participated in through **[Insert Local Agency from Sample]. [RECORD RATING, -98= DON'T KNOW, -99= REFUSED]**

C2. **[IF IN SAMPLE <Ceiling Insulation= Y>]** On a scale of 0 to 10 where 0 is not at all satisfied and 10 is completely satisfied, how satisfied are you with the ceiling insulation that was installed in your home through the Weatherization program? **[RECORD RATING, -98= DON'T KNOW, -99= REFUSED]**

C3. **[ASK IF C2 <5]** What was less than satisfactory about the ceiling insulation? **[RECORD RESPONSE, -98= DON'T KNOW, -99= REFUSED]**

C4. **[IF IN SAMPLE <Wall Insulation= Y>]** On a scale of 0 to 10 where 0 is not at all satisfied and 10 is completely satisfied, how satisfied are you with the wall insulation that was installed in your home through the Weatherization program? **[RECORD RATING, -98= DON'T KNOW, -99= REFUSED]**

C5. **[ASK IF C4 <5]** What was less than satisfactory about the wall insulation? **[RECORD RESPONSE, -98= DON'T KNOW, -99= REFUSED]**

C6. **[IF IN SAMPLE <Furnace Replacements= Y>]** On a scale of 0 to 10 where 0 is not at all satisfied and 10 is completely satisfied, how satisfied are you with the furnace that was installed in your home through the Weatherization program? **[RECORD RATING, -98= DON'T KNOW, -99= REFUSED]**

C7. **[ASK IF C6 <5]** What was less than satisfactory about the furnace upgrade? **[RECORD RESPONSE, -98= DON'T KNOW, -99= REFUSED]**

C8. **[IF IN SAMPLE <Refrigerator Replacement= Y>]** On a scale of 0 to 10 where 0 is not at all satisfied and 10 is completely satisfied, how satisfied are you with the refrigerator that was installed in your home through the Weatherization program? **[RECORD RATING, -98= DON'T KNOW, -99= REFUSED]**

C9. **[ASK IF C8 <5]** What was less than satisfactory about the refrigerator replacement? **[RECORD RESPONSE, -98= DON'T KNOW, -99= REFUSED]**

C10. **[IF IN SAMPLE <CFL Lighting Package= Y>]** On a scale of 0 to 10 where 0 is not at all satisfied and 10 is completely satisfied, how satisfied are you with the CFLs that were installed in your home through the Weatherization program? **[RECORD RATING, -98= DON'T KNOW, -99= REFUSED]**

C11. **[ASK IF C10 <5]** What was less than satisfactory about the CFLs? **[RECORD RESPONSE, -98= DON'T KNOW, -99= REFUSED]**

Now I am going to ask you a few questions about your experience with the installation of the energy saving upgrades in your home.

C12. On a scale of 0 to 10 where 0 is not at all satisfied and 10 is completely satisfied, how satisfied were you with how the energy saving equipment was installed in your home? **[READ LIST]**

1. **[IF IN SAMPLE <Ceiling Insulation= Y>]** Ceiling Insulation **[RECORD RATING]**
2. **[IF IN SAMPLE <Wall Insulation= Y>]** Wall insulation **[RECORD RATING]**
3. **[IF IN SAMPLE <Furnace Replacements= Y>]** Furnace upgrade **[RECORD RATING]**
4. **[IF IN SAMPLE <Refrigerator Replacement= Y>]** Refrigerator replacement **[RECORD RATING]**
5. **[IF IN SAMPLE <CFL Lighting Package= Y>]** CFLs **[RECORD RATING]**

-98 DON'T KNOW
-99 REFUSED

C13. **[ASK IF C12= ANY MEASURES <5]** What was less than satisfactory about the [MEASURE] installation? **[RECORD RESPONSE, -98= DON'T KNOW, -99= REFUSED; REPEAT FOR ADDITIONAL MEASURES RATED <5]**

C14. Thinking about the comfort level of your home since the weatherization upgrades were installed, has it been? **[READ LIST]**

1. Much less comfortable
2. Less comfortable
3. The same—with no change in comfort level
4. More comfortable
5. Or much more comfortable

-98 DON'T KNOW
-99 REFUSED

C15. Do you think your monthly energy bill has decreased since the Home Weatherization visit?

1. Yes
2. No
3. Have not been able to see a difference

-98 DON'T KNOW
-99 REFUSED

C16. What would you change to make the Home Weatherization Program better? **[DO NOT READ]**

1. Nothing
2. Less wait time (to get into program, to get measures installed)
3. Offer more types of equipment
4. Offer customers more choice in equipment brands
5. Provide more instructions on how to operate the new equipment
6. Provide more information on how to reduce bills and save energy in my home
7. Fewer phone calls from schedulers, implementation staff, QC staff
8. Specify: _____

-98 DON'T KNOW
-99 REFUSED

C17. Did your energy auditor indicate any other ways to save energy that were not provided as a part of the Program that you feel should have been included in the Weatherization Program?

1. Yes (Specify: _____)
2. Nothing

-98 DON'T KNOW
-99 REFUSED

C18. Have you participated in any other (i.e., not weatherization) energy efficiency rebate programs offered by Xcel Energy?

1. Yes
2. No **[SKIP TO D1]**

-98 DON'T KNOW **[SKIP TO D1]**
-99 REFUSED **[SKIP TO D1]**

C19. Which programs? DO NOT READ

1. Saver's Switch (A/C recycling)
2. Home Lighting (CFLs via Xcel Energy's website)
3. Furnace Rebate
4. Boiler Rebate
5. Water Heater Rebate
6. Home Energy Audit
7. Insulation Rebate
8. Other (Specify : _____)

-98 DON'T KNOW
-99 REFUSED

D. Information/ Knowledge

D1. As a result of participating in Xcel Energy's Home Weatherization Program would you say your familiarity with energy saving equipment has … **[READ LIST]**

1. Increased significantly
2. Increased somewhat
3. Stayed the same
4. Decreased somewhat
5. Decreased significantly

-98 DON'T KNOW
-99 REFUSED

D2. Did the equipment installers leave any materials with you about other things you could do to save energy and money?

1. Yes
2. No **[Skip to D4]**

-98 DON'T KNOW **[Skip to D4]**
-99 REFUSED **[Skip to D4]**

D3. On a scale of 0 to 10, where 0 is not at all satisfied and 10 is completely satisfied, how satisfied were you with the information the installer provided? **[RECORD RATING, -98= DON'T KNOW, -99= REFUSED]**

D4. Are there any other informational materials about the Program you would like to see?

1. Yes (Specify: _____)
2. No

-98 DON'T KNOW
-99 REFUSED

D5. Altogether, how many in-home visits did you receive throughout your participation in this program? Please include the initial audit as well. **[RECORD RESPONSE, -98= DON'T KNOW, -99= REFUSED]**

D6. Altogether, about how many telephone calls did you receive throughout your participation in this program? Please include any calls regarding scheduling, follow up and this call. **[RECORD RESPONSE, -98= DON'T KNOW, -99= REFUSED]**

D7. After submitting your application, for about how long did you have to wait before you were notified that you qualified for the program? **[RECORD RESPONSE, -98= DON'T KNOW, -99= REFUSED] DO NOT READ**

1. Less than one month
2. 1 to 2 month
3. 2 to 3 months
4. 3 to 4 months
5. 4 to 5 months
6. 5 to 6 months
7. 6 to 7 months
8. 7 to 8 months
9. 8 to 9 months
10. 9 to 10 months
11. 10 to 11 months
12. 11 to 12 months
13. A year or more

D8. And, after you were notified, for about how long did you have to wait before the auditor visited your home? **DO NOT READ [RECORD RESPONSE, -98= DON'T KNOW, -99= REFUSED]**

1. Less than 2 weeks
2. 2 to 4 weeks
3. 1 to 2 months
4. 2 to 3 months
5. 3 to 4 months
6. 4 to 5 months
7. 5 to 6 months
8. 6 to 7 months
9. 7 to 8 months
10. 8 to 9 months
11. 9 to 10 months
12. 10 to 11 months
13. A year or more

E. Spillover

E1. As a result of the visit from [INSERT AGENCY] have YOU made any changes to make your home more energy efficient?

1.	Yes	
2.	No	**[SKIP TO F1]**
-98	DON'T KNOW	**[SKIP TO F1]**
-99	REFUSED	**[SKIP TO F1]**

E2. What changes have you made? **[RECORD RESPONSES IN TABLE]**

Equipment / Improvement	E2. **[Indicate mentioning with 'Y']**	E2a. **[If E2=Y]** Is the [MEASURE] ENERGY STAR certified?	E2b. **[If E2a=Y]** Did you receive a rebate from another utility for any of the additional equipment installed?	E2c. **[If E2b=Y]** which utility or rebate program was it?	E2d. On a scale of 0 to 10, where 0 = "not at all important" and 10 = "very important" Please indicate how important your participation in the weatherization program was in
1. Room A/C					
2. Clothes washer					
3. Dishwasher					
4. Duct sealing					
5. Furnace					
6. HVAC system					
7. Insulation		N/A- DO NOT ASK			
8. Lighting					
9. Pool equipment					
10. Programmable Thermostat		N/A- DO NOT ASK			
11. Refrigerator/ freezer					
12. Solar PV system		N/A- DO NOT ASK			
13. Television					
14. Water heater					
15. Whole house fan					
16. Window/door					

17. Weather-stripping		N/A- DO NOT ASK			
18. Putting plastic on windows		N/A- DO NOT ASK			
19. Other, Specify 1					
20. Other, Specify 2					

E3. Do you plan to make any further energy-saving upgrades in the next 12 months as a result of the Home Weatherization visit?

1. Yes
2. No **[SKIP TO F1]**
-98. DON'T KNOW **[SKIP TO F1]**
-99 REFUSED **[SKIP TO F1]**

E4. What upgrades do you plan to make? **[RECORD RESPONSE, -98= DON'T KNOW, -99= REFUSED]**

F. Other Equipment

F1. What kind of cooling equipment do you use at home? DO NOT READ

1. Central AC
2. Room AC
3. Evaporative cooler
4. Ceiling fan
5. Whole house fan
6. Free standing fan (e.g., floor or box fan)
7. None
8. Other (Specify: _____)
-98 DON'T KNOW
-99 REFUSED

IF F1 > 3, Go to F6

F1a. **[IF F1= 1, 2, OR 3]** Out of the following statements which best describes your cooling use?

1. I use the thermostat to automatically maintain certain temperatures at different times of the day/night
2. I usually have the AC **on** and keep it running at the same temperature most of the time in the summer
3. I usually have the AC **on** and manually adjust the temperature daily for comfort
4. I usually have the AC **on** and manually adjust the temperature daily for times when the house is unoccupied
5. I usually have the AC **off** and turn it on only for a few hours a day
6. I turn the AC on only when absolutely needed, maybe a few times a month
7. I rarely use the AC (less than a few times per month)
8. None of the above/Other (Specify:_____)

-98. DON'T KNOW
-99 REFUSED

F2. **[IF F1= 1, 2, OR 3]** Do you have a programmable thermostat in your home?

1. Yes
2. No **[SKIP TO F6]**

-98 DON'T KNOW **[SKIP TO F6]**
-99 REFUSED **[SKIP TO F6]**

F3. Was it installed professionally?

1. Yes
2. No **[SKIP TO F5]**

-98 DON'T KNOW **[SKIP TO F5]**
-99 REFUSED **[SKIP TO F5]**

F4. Did the professional show you how to program the temperature settings on your thermostat?

1. Yes
2. No

-98 DON'T KNOW
-99 REFUSED

F5. Do you use the programmable temperature settings to automatically adjust the temperatures in your home? (i.e., lower the temperatures at night while people are asleep or during the day when no one is home?)

1. Yes
2. No

-98 DON'T KNOW
-99 REFUSED

F6. Do you have a clothes washer and/or dryer in your home?

1. Clothes washer
2. Clothes dryer
3. Both
4. Neither

-98 DON'T KNOW
-99 REFUSED

G. Demographics

Finally, I have a few general questions for statistical purposes. This information will be combined across all respondents and will not be shared with anyone outside the evaluation team in any way that identifies you or your household.

G1. Which of the following would you say best describes your home? Is it a … **[READ LIST]**

1. Single-family detached house
2. Single-family attached house (duplex, townhouse, row house)
3. Condo/ apartment
4. Mobile/manufactured home
5. Other (Specify: _____)

-98 DON'T KNOW
-99 REFUSED

G2. What is the total heated square footage of your home?

1. Less than 1,000 square feet
2. 1,000 to 1,499 square feet
3. 1,500 to 1,999 square feet
4. 2,000 to 2,499 square feet
5. 2,500 to 2,999 square feet
6. 3,000 to 3,999 square feet
7. 4,000 or greater

-98 DON'T KNOW
-99 REFUSED

G3. Do you rent or own your current residence?

1. Rent
2. Own

-98 DON'T KNOW
-99 REFUSED

G4. How long have you lived at this residence? **[RECORD RESPONSE, -98= DON'T KNOW, -99= REFUSED]**

G5. Is your main heating source electric, natural gas, propane or some other type?

1. Electric
2. Natural gas
3. Propane
4. Other (Specify_____)
5. Don't know

G6. What energy source do you use to heat your water?

1. Natural gas
2. Electric
3. Propane
4. Oil
5. Other (Specify: _____)

-98 DON'T KNOW
-99 REFUSED

G7. Including yourself, how many people are in your household? [This number should include all members of your household whether or not they are related to you, but do not include anyone who is just visiting or children who may be away at college or in the military.] **[RECORD RESPONSE, -98= DON'T KNOW, -99= REFUSED]**

G8. What is the highest level of education you have completed?

1. High school graduate or less
2. Some college (including Associate's degree)
3. Bachelor's degree
4. Graduate study or degree

-98 DON'T KNOW
-99 REFUSED

G9. Which of the following best represents your age? **[TARGETING THE RESPONDENT] [READ LIST]**

1. 18-24
2. 25-34
3. 35-44
4. 45-54
5. 55-64
6. 65 or older

-98 DON'T KNOW
-99 REFUSED

H. Conclusion

H1. Those are all the questions I had. Do you have any questions for me?

1. Yes (Specify: _____)
2. No

H2. May we share your individual responses with Xcel Energy so they can serve their customers better?

1. Yes
2. No

H3. Respondent's gender **[RECORD, BUT DO NOT ASK]**

1. Male
2. Female

Thank you very much for your time! Your input will help ensure the quality of the Home Weatherization Program.

On-site Data Collection Form

General	Debtor Number
	Customer Name
	Address
	City
	Phone
	Date of Visit
	Time
	Oudoor Temperature
	Indoor Temperature
	Stories
	Year Built
	Conditioned Square Footage
	Bedrooms
	Bathrooms
	Number of Corners
	% Open to Level Above:
	ceiling height
	vaulted ceiling %
	Perimeter
Foundation	type
	Foundation Wall Type
	Foundation Floor Type
	notes:
If Mobile Home	length
	width
	height
	notes:
Attic Insulation	Area
	Type 1 Depth
	Type 1 Material
	Type 2 Depth
	Type 2 Material
	Type 3 Depth
	Type 3 Material
	Total R value
	Grade
	Picture
	Notes:

Wall Insulation	framing
	Ceiling Height
	ceiling height 2
	Perimeter
	Outlet 1 insulation Type
	r-value
	Gaps Detected with IR Camera
	gap area wall 1
	gap area wall 2
	gap area wall 3
	gap area wall 4
	Pictures
	Notes:
Door	Door type
	door area
	Weather stripping complete
	gaps
	intact
	type
	IR picture
	pictures
	Notes:
Door 2	Door2 type
	door2 area
	Weather stripping complete
	gaps
	intact
	type
	IR picture
	pictures
	Notes:
Door 3	Door3 type
	door3 area
	Weather stripping complete
	gaps
	intact
	type
	IR picture
	pictures
	Notes:

Door 4		Door 4 type
		door 4 area
		Weather stripping complete
		gaps
		intact
		type
		IR picture
		pictures
		Notes:
Door 5		Door 5 type
		door 5 area
		Weather stripping complete
		gaps
		intact
		type
		IR picture
		pictures
		Notes:
Windows		Side 1 Area
		Side 1 Direction
		Side 1 Panes
		frame
		Overhang
		to top of window
		to bottom of window
	Interior Shading	winter
		summer
	Adjacent Shading	winter
		summer
		notes
		side 1 type 2 area
		side 1 type 2 panes
		side 1 type 2 frame
		overhang
		to top of window
		to bottom of window
	Interior Shading	winter
		summer
	Adjacent Shading	winter
		summer
		notes

Windows		side 1 type 3 area
		side 1 type 3 panes
		side 1 type 3 frame
		overhang
		to top of window
		to bottom of window
	Interior Shading	winter
		summer
	Adjacent Shading	winter
		summer
		notes:
		side 1 type 4 area
		side 1 type 4 panes
		side 1 type 4 frame
		overhang
		to top of window
		to bottom of window
	Interior Shading	winter
		summer
	Adjacent Shading	winter
		summer
		notes:
		Side 2 Area
		Side 2 Direction
		Side 2 Panes
		Side 2 Frame
		Overhang
		to top of window
		to bottom of window
	Interior Shading	winter
		summer
	Adjacent Shading	winter
		summer
		notes

Windows		side 2 type 2 area
		side 2 type 2 panes
		side 2 type 2 frame
		type 2 overhang
		type 3 top
		type 2 bottom
	Interior Shading	winter
		summer
	Adjacent Shading	winter
		summer
		notes:
		side 2 type 3 area
		side 2 type 3 panes
		side 2 type 3 frame
		type 3 overhang
		type 3 top
		type3 bottom
	Interior Shading	winter
		summer
	Adjacent Shading	winter
		summer
		notes:
		side 2 type 4 area
		side 2 type 4 panes
		side 2 type 4 frame
		type 4 overhang
		type 4 top
		type4 bottom
	Interior Shading	winter
		summer
	Adjacent Shading	winter
		summer
		notes:

Windows		Side 3 Area
		Side 3 Direction
		Side 3 Panes
		Side 3 Frame
		Overhang
		to top of window
		to bottom of window
	Interior Shading	winter
		summer
	Adjacent Shading	winter
		summer
		notes
		Side 3 type 2Area
		Side 3 type 2 Panes
		Side 3 type2 Frame
		type 2 Overhang
		to top of window
		to bottom of window
	Interior Shading	winter
		summer
	Adjacent Shading	winter
		summer
		notes
		Side 3 type 3 Area
		Side 3 type 3 Panes
		Side 3 type 3 Frame
		type 3 Overhang
		to top of window
		to bottom of window
	Interior Shading	winter
		summer
	Adjacent Shading	winter
		summer
		notes

Windows		Side 3 type 4 Area
		Side 3 type 4 Panes
		Side 3 type 4 Frame
		type 4 Overhang
		to top of window
		to bottom of window
	Interior Shading	winter
		summer
	Adjacent Shading	winter
		summer
		notes
		Side 3 type 5 Area
		Side 3 type 5 Panes
		Side 3 type 5 Frame
		type 5 Overhang
		to top of window
		to bottom of window
	Interior Shading	winter
		summer
	Adjacent Shading	winter
		summer
		notes
		Side 3 type 6 Area
		Side 3 type 6 Panes
		Side 3 type 6 Frame
		type 6 Overhang
		to top of window
		to bottom of window
	Interior Shading	winter
		summer
	Adjacent Shading	winter
		summer
		notes

Windows		Side 3 type 7 Area
		Side 3 type 7 Panes
		Side 3 type 7 Frame
		type 7 Overhang
		to top of window
		to bottom of window
	Interior Shading	winter
		summer
	Adjacent Shading	winter
		summer
		notes
		Side 4 Area
		Side 4 Direction
		Side 4 Panes
		Side 4 Frame
		Overhang
		to top of window
		to bottom of window
	Interior Shading	winter
		summer
	Adjacent Shading	winter
		summer
		notes
		Side 4 type 2 Area
		Side 4 type 2 Panes
		Side 4 type2 Frame
		type 2 Overhang
		to top of window
		to bottom of window
	Interior Shading	winter
		summer
	Adjacent Shading	winter
		summer
		notes

Windows		Side 4 type 3 Area
		Side 4 type 3 Panes
		Side 4 type 3 Frame
		type 3 Overhang
		to top of window
		to bottom of window
	Interior Shading	winter
		summer
	Adjacent Shading	winter
		summer
		notes
		Side 4 type 4 Area
		Side 4 type 4 Panes
		Side 4 type 4 Frame
		type 4 Overhang
		to top of window
		to bottom of window
	Interior Shading	winter
		summer
	Adjacent Shading	winter
		summer
		notes
		Side 4 type 5 Area
		Side 4 type 5 Panes
		Side 4 type 5 Frame
		type 5 Overhang
		to top of window
		to bottom of window
	Interior Shading	winter
		summer
	Adjacent Shading	winter
		summer
		notes
	Weatherization	Weather stripping complete
		gaps
		intact
		type
		IR picture
		pictures
		Notes:

Furnace	Location
	Make
	Model Number
	Serial Number
	Input kBtu
	Output kBtu
	AFUE
	Notes:
Furnace 2	Location 2
	Make 2
	Model Number
	Serial Number
	Input kBtu
	Output kBtu
	AFUE
	Notes:
Cooling	Location
	CAC
	Ceiling Fans
	if ceiling fan wattage
	Room AC
	Evaporative Cooler
	Notes:
Water Heater	Gallons
	Fuel
	Notes:

Tstat Set Points	General		Heating
			Cooling
			Programmable
			using program
			notes:
	Heating	Monday - Friday	time
			Set point
			time
			Set point
			time
			Set point
			time
			Set point
		Weekend	time
			Set point
			time
			Set point
			time
			Set point
			time
			Set point
	Cooling	Monday - Friday	time
			Set point
			time
			Set point
			time
			Set point
			time
			Set point
		Weekend	time
			Set point
			time
			Set point
			time
			Set point
			time
			Set point
			Notes:

Duct Work	Location 1
	%
	Location 2
	%
	Location 3
	%
	Notes:
Refrigerator	Make
	Model Number
	Serial Number
	Full
	cubic feet
	adjusted cubic feet
	annual kWh
	Notes:
Refrigerator 2	Make 2
	Model Number type 2
	Serial Number2
	Full 2
	cubic feet 2
	adjusted cubic feet 2
	annual kWh 2
	Notes:
Appliances	Dishwasher
	Stove
	Washer
	Dryer
Lighting	Total Lamps
	CFL's
	Incandescent
	tube
	Notes: