Designing an Effective Employee Energy Efficiency Program:

A Review of Duke Carbon Offsets Initiative's Energy Efficiency Pilot Programs

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May 2016

UNC ENVIRONMENTAL FINANCE CENTER

Duke Carbon Offsets Initiative
DUKE UNIVERSITY

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The Environmental Finance Center at the University of North Carolina, Chapel Hill (EFC) is part of a network of university-based centers that work on environmental issues, including water resources, solid waste management, energy, and land conservation. The EFC at UNC partners with organizations across the United States to assist communities, provide training and policy analysis services, and disseminate tools and research on a variety of environmental finance and policy topics.

About the Duke Carbon Offsets Initiative

Duke University established the Duke Carbon Offsets Initiative (DCOI) in June 2009 to help meet its goal of climate neutrality by 2024. The University will need to offset approximately 185,000 tons of carbon dioxide-equivalent emissions per year, starting in 2024. The Initiative is responsible for developing the University's strategy for meeting its offset goals in a way that provides significant local, state and regional environmental, economic, and societal co-benefits beyond the benefits of greenhouse gas emission reductions.

Acknowledgments

This report represents a collaborative effort between the EFC and the DCOI and is a joint product of the two organizations. The report was co-authored by Charles Adair, Program Manager of the DCOI, Jennifer Weiss, previously a Senior Finance Analyst at the EFC, and Jason Elliott, a Program Coordinator at the DCOI. This research would not have been possible without the support of Daniel Kauffman, the General Manager of ResiSpeak, Erin Leon, Aaron Newman, and Catherine Bowler, research assistants at the DCOI, Keith Canfield and Ryan Boswell of the Clinton Climate Initiative, and Tatjana Vujic, the Director of the DCOI until March 2014. Editorial assistance was provided by Alexandra Kay Herndon of the EFC. Cover photo courtesy of Yumian Deng CCBY.

Findings, interpretations, and conclusions included in this report represent those of the authors and do not necessarily reflect the views of EFC funders, the University of North Carolina, the School of Government, Duke University, or those who provided review.

We are grateful to The Duke Endowment for funding this research.

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INTRODUCTION

Residential energy efficiency offers a unique way to simultaneously reduce energy use in buildings, lower energy bills for consumers, improve the comfort of homes, and generate carbon offsets. However, many homeowners who could benefit from energy efficiency retrofits are unable to, due to a number of common barriers that make the retrofit process challenging. For example, homeowners may not know what types of retrofits to complete, may not have the time to oversee the retrofit, and may not be able to pay for the retrofit up-front.

In 2012, Duke University began a five-year effort to identify these barriers and determine the best strategies to overcome them. The goal of this research is to design a program that helps Duke employees complete energy efficiency home retrofits and tracks carbon offsets generated from the post-retrofit energy savings. This paper evaluates the results of Duke's pilot energy efficiency programs and makes recommendations for Duke and other employers implementing employee-based energy efficiency programs.

BACKGROUND

In 2007, Duke University signed the American Colleges and Universities Presidents Climate Commitment (ACUPCC) and set a goal to become a climate neutral institution by 2024. To reach this voluntary goal, Duke University must eliminate approximately 366,000 metric tons of carbon dioxide equivalent ($mtCO_2e$) annual emissions. Starting with an aggressive push to reduce on-campus CO_2 emissions, the University aims to achieve a 50% reduction through a combination of conservation, energy efficiency, green building initiatives, solar photovoltaic installations, and alternative transportation options. The remaining 183,000 $mtCO_2e$ will be addressed through greenhouse gas (GHG) emission reduction projects that generate carbon offsets.[1]

In 2009, the Duke Carbon Offsets Initiative (DCOI) was created to identify and develop innovative carbon offset projects. To prepare for the carbon neutrality commitment, the DCOI focuses on a variety of project areas that it considers most promising in terms of volume, cost-effectiveness and co-benefits to the university and surrounding communities. Co-benefits include educational, environmental, economic and social benefits created by the project *in addition* to the emission reductions.[2] Four main project types were selected that meet these criteria: swine waste-to-energy, urban forestry, distributed renewable energy, and energy efficiency. Through an initial review of established carbon offset projects in the Southeast, the DCOI discovered that the identified project types did not exist locally to the scale needed to support the upcoming climate commitments of Duke University and other ACUPCC schools. Therefore, the DCOI began

[1] Board of Trustees, "Duke Climate Action Plan," Duke University (October 2009)
[2] For more information on co-benefits, see the DCOI publication http://sustainability.duke.edu/carbon_offsets/cobenefitsguide.pdf

research and development of these project types to bring them to scale. To-date, the DCOI has developed pilot projects in each of these four areas.

Of the four project types, residential energy efficiency projects are unique in their scalability and their capacity to benefit the local community in Durham, NC. Programs that assist with energy efficiency retrofits lead to energy savings and long-term building improvements for participants. These energy savings and building improvements translate into financial savings and more comfortable living environments, respectively. In addition, the reduction in energy use decreases the need for energy production, which is often the most significant source of local emissions (e.g. coal or natural gas power plants). With over 130 million homes in the US[3], the opportunity to scale such programs is immense.

Recognizing that employers are uniquely positioned to facilitate or implement energy efficiency programs and that many employers have incentive to do so,[4] Duke University began a five-year research study to design an employee energy efficiency program and determine how to bring such a program to scale.[5] In 2014, the DCOI partnered with the Clinton Climate Initiative and the Environmental Finance Center at the University of North Carolina-Chapel Hill (EFC) to create the DCOI Home Energy Affordability Loan (DCOI-HEAL) pilot program. This paper provides a recap of the DCOI's energy efficiency research to-date and an in-depth review of the DCOI-HEAL pilot program – including the program's design, results, and final recommendations. The paper concludes with recommendations for scaling such a program within the Duke University community and beyond.

RESEARCH OBJECTIVES AND METHODS

Investment in energy efficiency is widely recognized as one of the lowest cost ways to reduce energy use and carbon emissions.[6] However, many energy efficiency programs face barriers to implementation that limit energy reduction opportunities. These barriers can be informational (e.g., homeowners may be unfamiliar with the benefits of energy efficiency or unsure how to participate in programs), related to decision-making (e.g., homeowners may misunderstand the scope of work) or transactional (e.g., homeowners may not know how to select a contractor or find funding for the energy efficiency work).[7] The goal of the DCOI-HEAL project was to design and test a pilot program to determine the ability of Duke as an employer to effectively administer an energy efficiency program for its employees by eliminating or reducing these implementation barriers.

While there is a significant amount of research available on energy efficiency and strategies for creating energy efficiency programs, there are very few examples of programs that focus on leveraging the employer-employee relationship to encourage residential energy efficiency retrofits and achieve local emissions reductions. In this way, the goals of DCOI are unique and require an innovative program design. Therefore, the DCOI uses an iterative research and development process that relies on implementing pilot projects to test the effectiveness of innovative program designs. This iterative process serves as a "living lab" for students, staff, and faculty to learn about energy efficiency, carbon offsets, and program development. Duke community members have the opportunity to assist with program development, access

[3] US Census Bureau. (2015) www.census.gov
[4] Leveraging the Employer-Employee Relationship to Reduce Greenhouse Gas Emissions at the Residential Level, Charles Adair, Jennifer Weiss, and Jason Elliott, December 2015.
[5] This research program was made possible by support from The Duke Endowment.
[6] US Department of Energy. (2016) http://energy.gov/science-innovation/energy-efficiency
[7] Energy Advisors: Improving Customer Experience and Efficiency Program Outcomes, Billingsley, Megan A., Chris Stratton, and Emily Martin Fadrhonc, January 2016.

energy data collected from pilot projects for research purposes, and learn how to complete energy efficiency retrofits themselves.

Specifically, this process started with an initial literature review to identify general barriers to energy efficiency and the best practices for overcoming those barriers. A pre-pilot program was designed based on those findings to test a preliminary employee energy efficiency program that hired students to complete energy efficiency retrofits in employees' homes. Results from the pre-pilot, survey research, and research on carbon offsets protocols were then used to develop the larger DCOI-HEAL pilot program. This process is shown below.

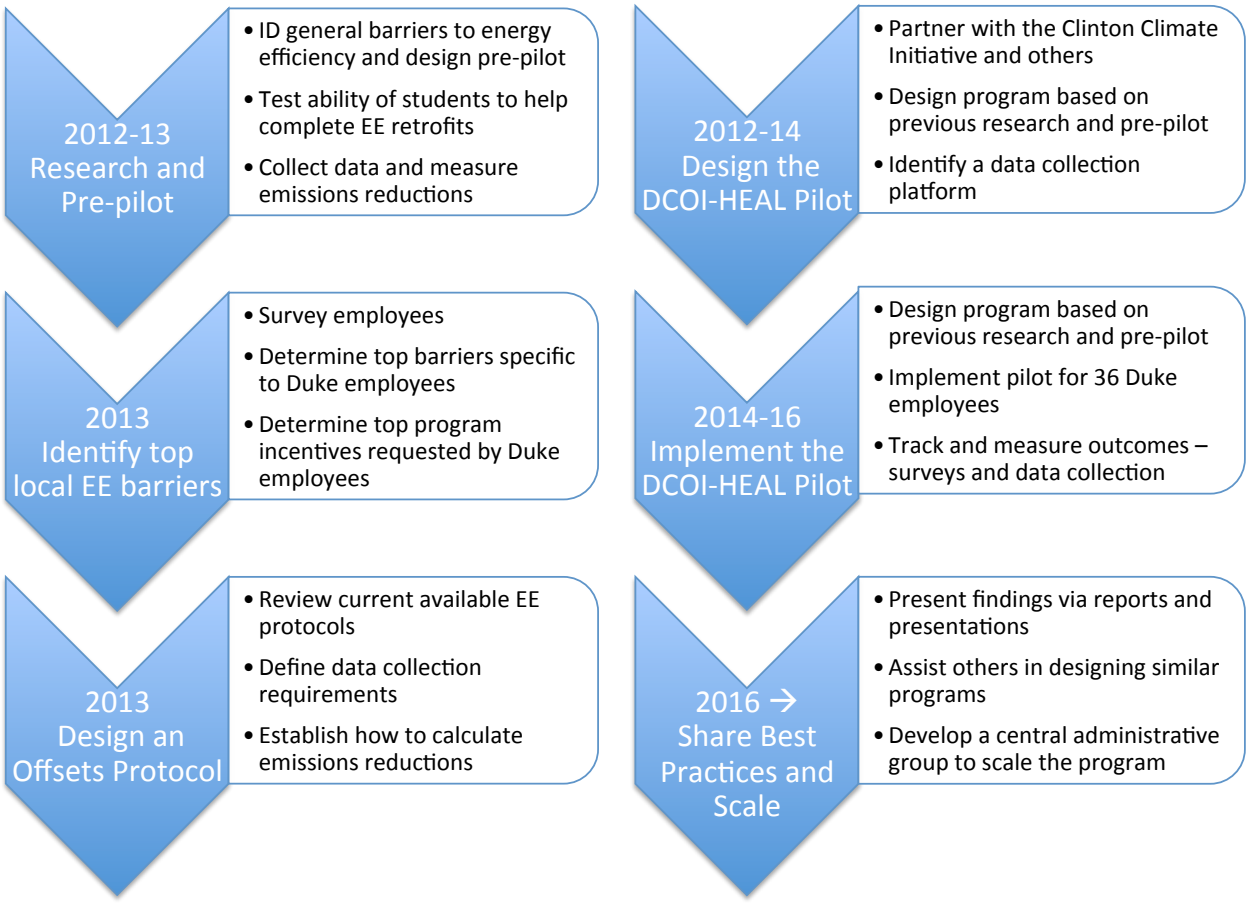

FIGURE 1. DCOI RESEARCH PROCESS FOR ENERGY EFFICIENCY

The following sections describe each step in this iterative research and development process and review:

- The challenges of designing and implementing the pre-pilot and pilot programs;
- The barriers to residential energy efficiency programs;
- The final DCOI-HEAL pilot program design;
- The results of the DCOI-HEAL pilot program (including the data requirements and limitations that currently exist);
- Lessons learned from the DCOI-HEAL pilot program;
- Recommendations for replicating the program; and
- Recommendations for scaling the program via a third party non-profit, potentially in partnership with local governments, utilities, and the state energy office.

DUKE UNIVERSITY INITIAL RESEARCH AND PRE-PILOT

In 2012, the DCOI received funding from The Duke Endowment and Piedmont Natural Gas to design and implement a pre-pilot energy efficiency program. The pre-pilot tested the potential to achieve greenhouse gas emission reductions through energy efficiency improvements beginning with twelve residential homes near Duke University.

To design the pre-pilot, the DCOI first conducted a literature review, spoke with university employees, and met with local energy efficiency administrators to identify general barriers to energy efficiency. Two main barriers were identified: (1) the upfront cost of energy efficiency retrofits, and (2) a lack of knowledge regarding retrofit options.

Using this information, the DCOI designed the first round of the pre-pilot to address both barriers simultaneously. Students were trained by an energy efficiency contractor to complete a prescriptive set of retrofits identified as common "low hanging fruit" – retrofits that benefit most houses and are relatively simple and inexpensive to implement. The students worked with the energy efficiency contractor to retrofit ("weatherize") eight houses at no cost to the employee. For the second round, students did not participate in the retrofits due to time constraints related to grant funding. Instead, the energy efficiency contractor completed all retrofits on four additional houses. The upgrades installed in the homes for both rounds included air and duct sealing to reduce leaks of heated or conditioned air to the attic or crawlspace of the home. The DCOI then calculated the greenhouse gas emissions reductions (carbon offsets) associated with documented decreases in energy use.

The initial round of weatherization was completed in August 2012 and the second round was completed in November 2013. The DCOI aimed to collect two years of post-weatherization data from each participant to measure energy savings (including reduction in electricity, natural gas, and propane use), and associated greenhouse gas reductions. These measurements were used to determine the carbon offset potential as well as to evaluate the cost per metric ton of carbon dioxide-equivalent reductions.

Pre-Pilot Results and Recommendations

The DCOI collected energy data for the pre-pilot by requesting copies of participants' energy bills, which proved more difficult than initially expected. For example, the DCOI was unable to collect consistent data from the round two houses due to a combination of participants moving away from the area and low data-request response rates. This reflects a common problem for many energy efficiency programs and was identified as one of the key challenges to address for future iterations of the program.

Despite the obstacles to collecting data from some of the homes, data from the pre-pilot were encouraging and suggested that a program that completes more extensive energy efficiency retrofits could achieve a 20% or higher reduction in energy use for the average household.[8] For the seven homes that the DCOI successfully collected pre- and post-retrofit data (all from the first round), energy use dropped an average of thirteen percent.[9] This average is weather normalized – adjusted statistically to take into account changes in weather that affect energy use over time. At this rate of energy savings, the DCOI expects these

[8] http://sustainability.duke.edu/carbon_offsets/resources/Energy%20Efficiency%20Resources/DCOI%20EE%20Pre-Pilot.pdf

[9] The eighth house was been removed as an outlier as there was a significant increase in energy use within that household. Thus, the DCOI will be reaching out to this household to document what has caused the increase in energy use.

seven homes to generate a combined total of approximately 50 carbon offsets over the life of the basic weatherization retrofits.

In addition to the challenge of collecting data, the pre-pilot revealed additional opportunities for improvement to the program design. First, relying on students to complete retrofits proved too time consuming from a program administration perspective to scale. The high overall cost of the program also limited scalability, because the DCOI was directly paying for all of the retrofit costs. Finally, feedback from participants suggested that other barriers to energy efficiency existed for employees, including lack of time, lack of trust in contractors, and lack of motivation to complete retrofits. Taking these pieces of information into account, the DCOI decided that the next pilot program should:

1) Identify a system or program that would allow for automatic data collection;
2) Design a program to facilitate energy efficiency retrofits, rather than pay for them directly; and
3) Further clarify, and identify strategies for overcoming barriers to energy efficiency for Duke University employees.

DUKE UNIVERSITY SURVEY AND FOCUS GROUP

Building on the results of the pre-pilot, the DCOI worked with a group of graduate students in the fall of 2013 to assess Duke employees' general understanding of and readiness to participate in an energy efficiency program, as well as the specific barriers to participation that would need to be addressed. The survey was sent to 445 employees at Duke University. These employees were selected from eight undergraduate and graduate academic departments including economics, biology, and Italian studies. Of the recipients, 52 employees completed the survey, which collected information on work demographics, characteristics of respondents' homes, knowledge of energy efficiency, and previous experience with energy efficiency improvements.

A majority of the respondents were faculty or administrative staff that have been working at Duke University for at least ten years (54 percent) and owned their home (79 percent). Greater than 50 percent of respondents felt that they did not know enough about energy efficiency and were unsure about how to begin the process of learning more.[10]

The main barriers to energy efficiency investments were identified by respondents as insufficient knowledge and cost of improvements, confirming the results of DCOI's initial research on the subject. However, the results also indicated three secondary barriers: lack of trust in contractors, lack of time, and lack of motivation to complete the retrofit process. These are discussed in more detail below.
Finally, the survey indicated that to persuade homeowners to increase the energy efficiency of their homes, a low-cost or free home energy audit and a low-interest rate loan would be the most desirable incentives.

Employees' Perceived Barriers to Energy Efficiency

Based on the employee surveys and an assessment of similar programs across the country, the DCOI identified five critical barriers to address in the development of the pilot program:[11]

[10] Anhalzer, G., Johnson, R., Osteen A., and Overton, S. (2013). *Duke Carbon Offsets Initiative: Employee Residential Energy Efficiency Pilot Program Survey Results*. Unpublished student project, Duke University, Durham, North Carolina.
[11] Leveraging the Employer-Employee Relationship to Reduce Greenhouse Gas Emissions at the Residential Level, Charles Adair, Jennifer Weiss, and Jason Elliott, December 2015.

1. **Lack of information** – A general lack of knowledge about the benefits of energy efficiency or the scope of a home retrofit can prevent many employees from investing in an energy upgrade. In addition, asymmetrical information between individuals and energy service providers can make deciding to invest in energy efficiency retrofits particularly challenging.

2. **Lack of trust** – Many employees lack trust in contractors, whose expertise is frequently needed to complete energy efficiency retrofits. Individuals may have had poor experiences with contractors in the past, or have difficulty trusting unfamiliar companies performing costly work they know little about.

3. **Lack of capital** – The upfront costs of energy efficiency retrofits can be significant and prevent many homeowners from taking action, especially if low interest rate loans are not available. [12]

4. **Lack of time** – An energy efficiency retrofit requires a significant time commitment on the part of the resident. Time and convenience constraints can prevent individuals from taking action, particularly when combined with the other barriers listed above.

5. **Lack of motivation** – With multiple demands on employees' time and finances, it is sometimes difficult for employees to prioritize an investment into energy efficiency, despite an understanding of the health, environmental and financial benefits.

Overcoming Barriers for Program Success

Taken together, these barriers create significant obstacles to reducing residential energy use and greenhouse gas emissions. To address these barriers, a program must be designed to build employee knowledge, establish trust, offer financing alternatives and streamline the retrofit process. Program elements should be combined to holistically address the barriers to energy efficiency investment. The DCOI identified general ways of addressing each barrier that are presented in the table below.

TABLE 1. THE BARRIERS TO ENERGY EFFICIENCY

Barrier	Potential program elements to address barrier
Lack of Information	• Provide public resources regarding energy conservation and efficiency, including training videos and fact sheets. • Share information through access to online resources, in-person consultations, expert presentations, community discussion, and other forums.[13] • Provide educational information to local sustainability champions, who then teach others about energy conservation and efficiency.
Lack of trust	• Vet local energy contractors and other vendors to help residents identify the best local contractors.[14]

[12]Having identified lack of capital as a key barrier, the DCOI conducted additional research on potential financing mechanisms that could be used by energy efficiency programs to make the cost of energy efficiency retrofits more accessible. The results of this research are presented in the paper "Financing Energy Efficiency - Based Carbon Offset Projects at Duke University" linked below: http://sustainability.duke.edu/carbon_offsets/resources/Energy%20Efficiency%20Resources/Financing%20Energy%20Efficiency%20Offsets.pdf

[13] Energy Advisors: Improving Customer Experience and Efficiency Program Outcomes, Billingsley, Megan A., Chris Stratton, and Emily Martin Fadrhonc, January 2016.

	• Define specific program standards that each participating contractor must meet. • Discuss the home energy assessment report with each participant and review scope of work. • Offer an independent third party test-out of completed work.
Lack of capital	• Offer financing options like low interest loan products or on-bill financing to help participants manage upgrade costs. • Help participants complete paperwork to streamline the process.
Lack of time	• Help participants set up and schedule energy efficiency audits and retrofits. • Provide a web portal that residents can use to track their audit reports, bids, and other information. • Assist participants with project management, including reminders and next steps.[15]
Lack of motivation	• Provide a streamlined process for ease of participation. • Use games and comparisons to incent friendly competition between employees and neighbors. • Offer energy advisory services and reminders.

DESIGNING A RESIDENTIAL ENERGY EFFICIENCY CARBON OFFSETS PROTOCOL

Having identified the barriers and potential options for overcoming them, the DCOI had all of the pieces needed to create an effective employee energy efficiency program. However, to ensure that carbon offsets were generated, the DCOI also had to create a residential energy efficiency carbon offsets protocol to track and calculate carbon offsets.

Any project that is designed to generate carbon offsets must meet specific criteria (permanent, additional, verifiable, enforceable, and real) to qualify for carbon offsets production. A carbon offset protocol is a collection of guidelines to help develop and monitor a program to ensure that the emission reductions generated meet these requirements. The DCOI reviewed current protocols available and determined that the Verified Carbon Standard's (VCS) Weatherization of Single Family and Multi-family Buildings protocol (VCS Protocol) [16] most closely fit the needs of the pilot programs. However, the VCS Protocol did not apply directly to an employee energy efficiency program, and thus the DCOI developed a custom internal protocol for energy efficiency carbon offsets based on the VCS Protocol. The DCOI-HEAL protocol outlines the program and data collection requirements, the procedure for demonstrating high-quality carbon offsets, and the methodology for calculating carbon offsets. The DCOI-HEAL protocol is available for review on the DCOI website.[17]

[14] Leveraging the Employer-Employee Relationship to Reduce Greenhouse Gas Emissions at the Residential Level, Charles Adair, Jennifer Weiss, and Jason Elliott, December 2015.
[15] Energy Advisors: Improving Customer Experience and Efficiency Program Outcomes, Billingsley, Megan A., Chris Stratton, and Emily Martin Fadrhonc, January 2016.
[16] The complete VCS protocol can be found here: http://www.v-c-s.org/methodologies/weatherization-single-family-and-multi-family-buildings-v11.
[17] http://sustainability.duke.edu/carbon_offsets/efficiencyprotocol

THE DCOI-HEAL PILOT PROGRAM

In 2012, while the pre-pilot was being conducted, DCOI received funding from The Duke Endowment to design, develop, and implement an employee-based energy efficiency program building on the best practices of the pre-pilot. DCOI partnered with the William J. Clinton Foundation's Clinton Climate Initiative (CCI) to bring a customized version of CCI's Home Energy Affordability Loan program (HEAL) pilot program to a select number of Duke employees.

Key Partners

To develop a well-rounded energy efficiency program, the DCOI developed many key partnerships in the region. These partners helped finalize the DCOI-HEAL program details and bring the pilot program to Duke University.

TABLE 2. DCOI - HEAL PROGRAM PARTNERS

Partner	Role in DCOI-HEAL Program
The Clinton Climate Initiative	The DCOI-HEAL program is based on templates, processes and guidance provided by the Clinton Climate Initiative's Home Energy Affordability Loan (HEAL) program.
The Environmental Finance Center at UNC-Chapel Hill	Provided financial analysis and product management support during the pilot program.
The NC Cooperative Extension and NC State University	Provided guidance and advice for building effective energy efficiency and conservation programs for residential homes.
Duke University Federal Credit Union	Offered a low-interest, unsecured loan that can be used by Duke employees to fund energy efficiency improvements. Payments are made through payroll deductions.
Energy Reduction Specialists	Provided home energy assessments to all employees and was the lead contractor for retrofit work.
ResiSpeak	Developed an online tool used to easily collect and analyze employees' utility data.
Duke Energy	Offers rebates for energy efficiency measures through the Smart$aver Program.
Advanced Energy	Provided test-out and quality assurance support at the end of each retrofit project.

DCOI-HEAL Program Elements

Each piece of the program is designed to remove the barriers to implementation outlined previously. To address lack of information, the DCOI hosted information sessions for all program participants. To increase trust in contractors, the program vetted each participating contractor and checked afterward on the quality of their work. In partnership with a local credit union, participants gained access to low interest loan products. Program staff assisted with scheduling appointments with contractors to facilitate effective communication between the parties and minimize the time and effort required from the participant. Finally, the DCOI is collecting energy data from all employees who participate to track the average energy

use reductions from energy efficiency retrofits using an automatic data collection program called ResiSpeak.[18]

The overall goal of the DCOI-HEAL pilot program was to encourage participants to perform energy efficiency upgrades within their homes by helping them become comfortable with the audit and retrofit processes. DCOI provided information and guidance throughout the program using the following services paid for by Duke University via grant funding:

1. A Building Performance Institute (BPI) certified energy audit of the participant's home;
2. Scheduling assistance for the audit;
3. A Personalized Energy Plan report (PEP) prepared by DCOI;
4. A list of vetted retrofit contractors;
5. Access to a low-interest loan rate from the Duke University Federal Credit Union;
6. A follow up Test-Out to ensure quality retrofit work was completed (if retrofit work is undertaken by the homeowner as part of this program).

The following image walks through the DCOI-HEAL barrier removal process.

[18] www.resispeak.com

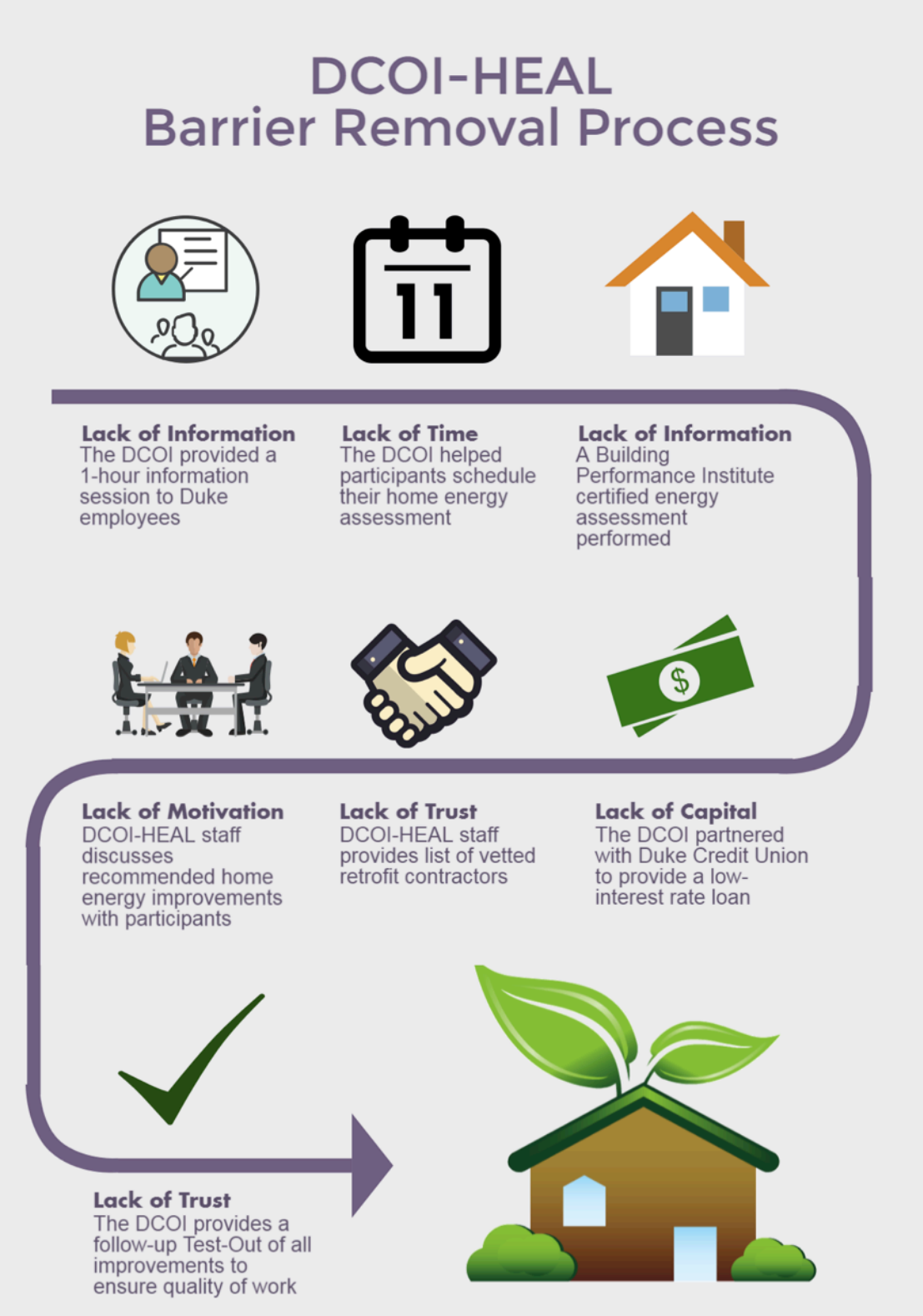

FIGURE 2. DCOI-HEAL BARRIER REMOVAL PROCESS.[19]

[19] All infographics were created using Piktochart - https://piktochart.com/

Summary of Program Participation

The DCOI-HEAL pilot program consisted of three rounds, with a total of 35 employees participating over a one-year period. Each employee was selected based on length of employment, housing characteristics and their perceived barriers to investing in energy efficiency measures.

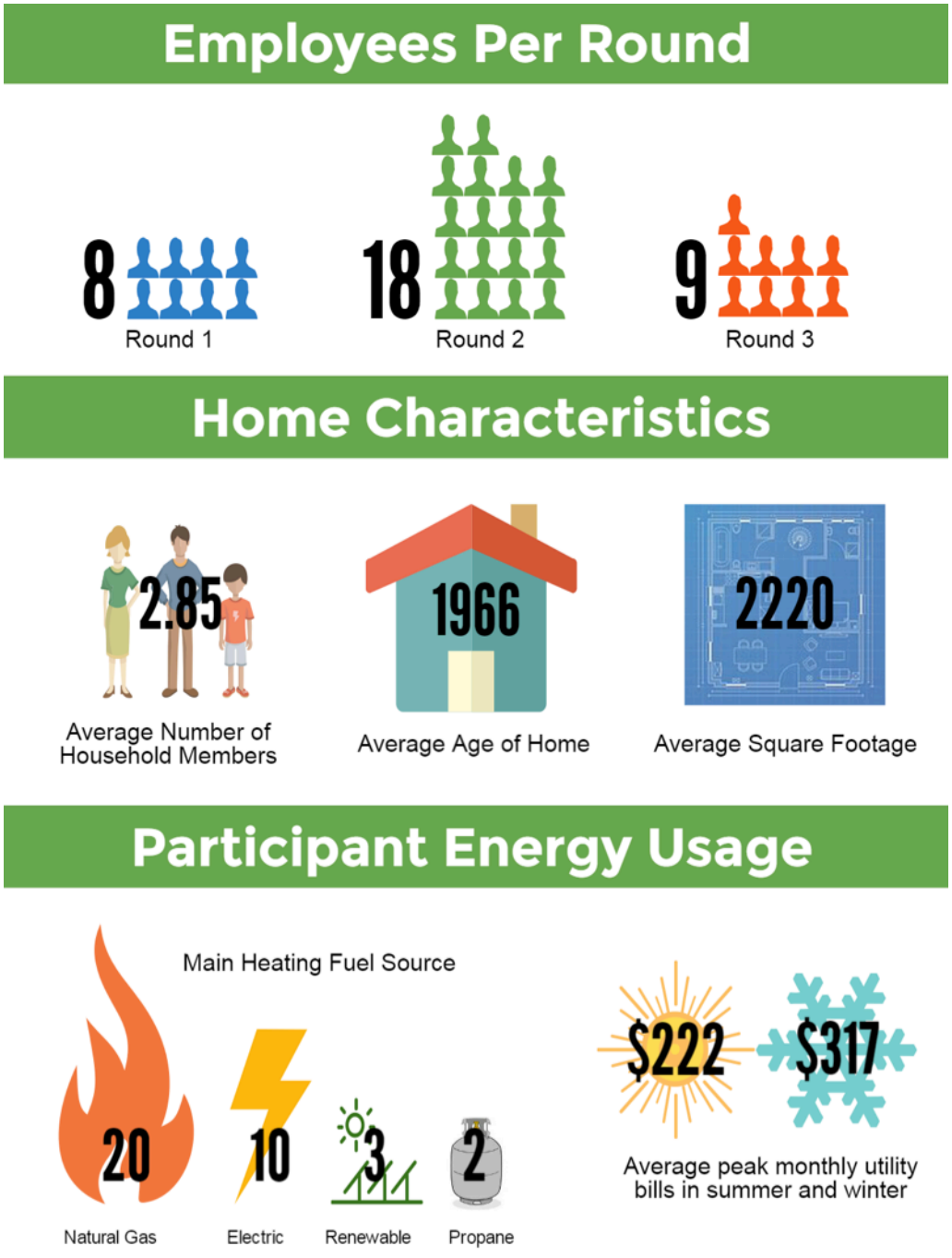

FIGURE 3. DCOI-HEAL SUMMARY OF PROGRAM PARTICIPATION

ANALYZING THE RESULTS TO-DATE

All 35 participants received a BPI-certified home energy assessment and met with DCOI staff to review a customized Personal Energy Plan. During the discussion of recommendations from the home assessment, employees were able to ask questions and identify measures that were projected to yield the greatest energy savings and home comfort improvements, given their specific situation.

Working with the program's contractors, twelve of the employees in the first two rounds scheduled retrofit work with an average investment of $4,400. An additional four employees completed work on their own, and two of the employees in Round 3 have indicated that they plan to complete retrofit work, bringing the total number of employees investing in energy efficiency measures to eighteen – over 50% of total participants. In addition, four of the employees took advantage of the low-interest loan that was offered through the employee credit union. The image below shows some of the different types of retrofits completed through the program.

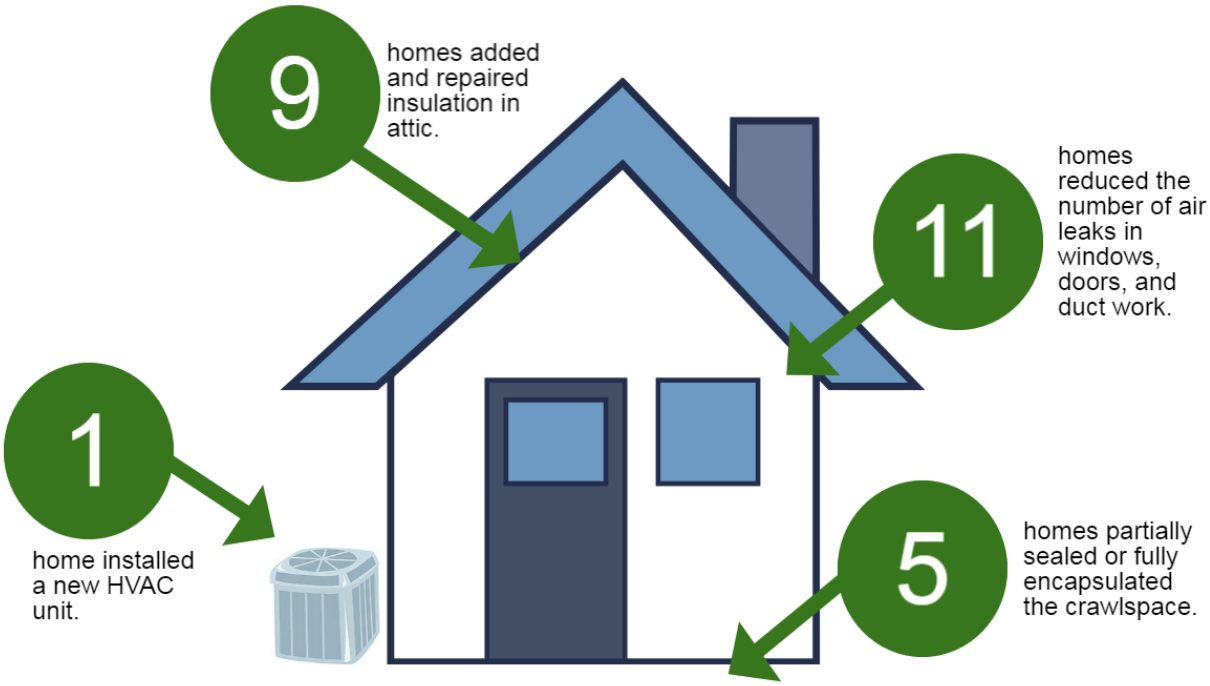

FIGURE 4. DCOI-HEAL GENERAL RETROFITS COMPLETED

Employee Participant Case Studies

Although the DCOI plans to complete a full analysis of the results of the pilot in the future, only four houses have one year of post-retrofit data to analyze thus far. Therefore, the following results include the energy savings results from those four houses and the overarching results from the program, based on data collected through March 31, 2016.

Using data collected through the ResiSpeak online portal,[20] the energy use performance of these four houses is detailed and summarized below:

[20] https://www.resispeak.com/login

TABLE 3. DETAILED ENERGY SAVINGS FROM FIRST FOUR HOUSES IN THE PILOT

	House 1		House 2		House 3		House 4	Total	
Size of Home (sq.ft.)	3,700		1,250		2,680		1,300		
Age of Home	1955		1961		1946		1986		
Date of Retrofit	1/22/2015		4/15/2015		4/24/2015		4/6/2015		
Amount of Retrofit	$4,425		$4,385		$5,850		$5,375	$20,035	
General EE Measures included in Retrofit	Air Sealing Duct Sealing Insulation repairs LEDs and CFLs Water heater insulation blanket Crawlspace vapor retarder		Air sealing Duct sealing Attic insulation Programmable Thermostat		Air sealing Duct sealing Attic insulation Installed crawlspace vapor retarder Vented 2 exhaust fans		Air Sealing Added insulation[21] Duct sealing and insulation Installed wind baffles Closed crawlspace		
	Electric	**Gas**	**Electric**	**Gas**	**Electric**	**Gas**	**Electric only**	**Electric**	**Gas**
Number of Post-Retrofit Billing Months	14	14	12	11	10	11	12	-	-
Total Pre-Retrofit Consumption, kWh or ccf	41,783	930	7,277	543	10,716	15	14,064	73,839	1,487
Total Post-Retrofit Consumption, kWh or ccf	34,400	871	5,945	444	10,572	12	12,209	63,126	1,327
Savings to Date, kWh or ccf	7,383	59	1,332	99	144	3	1,855	10,713	160
Savings to Date, %	17.7%	6.3%	18.3%	18.2%	1.3%	18.4%	13.2%	14.5%	10.8%
Savings to Date, $	$615	$42	$129	$90	$17	$2	$180	$941	$135

TABLE 4. SUMMARY OF ESTIMATED ANNUALIZED SAVINGS AND EMISSIONS REDUCTIONS

	House 1	House 2	House 3	House 4	All
Estimated Annualized % Electric Savings to Date	17.7%	18.3%	1.3%	13.2%	14.5%
Estimated Annualized % Gas Savings to Date	6.3%	18.2%	18.4%	NA	10.8%
Estimated Annualized Savings, $	$657	$219	$19	$180	$1,075
Estimated annual CO2 reductions in $mtCO_2e$[22]	3.92	1.36	0.12	1.07	6.46

The data show that homeowners have reduced their energy use by approximately 15% and their gas use by about 11%. House 1 has significantly higher energy savings, some of which may be attributed to the size of their home. House 3 has a geothermal heating system, which may explain why the savings rate is so low. The savings analysis shown above was conducted with a full ASHRAE-14 compliance record and the results could be used in the future to prove energy savings for the EPA's Clean Power Plan, state level utility commissions, or other regulatory measurement and verification requirements.

[21] Added insulation to existing, but lacking, levels of insulation

[22] Calculated using the average between the EPA eGRID emissions # for non-baseload output emission rate (1.79 lbs CO_2/kWh) and Duke Energy's baseload output emission rate (.74 lbs CO_2/kWh) for the region for a conservative emissions factor of 1.27 lbs CO_2/kWh.

Projections for Energy Reduction and Carbon Offset Estimates

The cost per carbon offset is an important metric in evaluating whether an expanded employee energy efficiency program could be part of a strategy to achieve climate neutrality. The total cost of the program was $36,000 with an average cost a little over $1,000 per participant. The total cost of the program includes the cost of the audits and tax gross-ups for each home and also the cost of the test-out for homes that received retrofits. The table below shows the expected carbon offsets generated by the program and the final cost per offset based on different energy savings scenarios.

TABLE 5. EXPECTED CARBON OFFSETS AND FINAL COST PER OFFSET

	DCOI-HEAL average - first four houses[23]	10% expected energy savings per house[24]	15% expected energy savings per house	20% expected energy savings per house	25% expected energy savings per house
Estimated offsets per house[25]	16.15	6.38	9.57	12.76	15.95
Estimated cost per offset	$124	$313	$209	$157	$125

The chart above shows that the DCOI-HEAL program is generating a relatively high number of offsets per house even though the average energy savings rate per house falls within the 10-15% range. This is due to the higher average pre-retrofit energy use of houses in the DCOI-HEAL program compared to the EPA average for houses in the US. This indicates that careful selection of houses can greatly impact the cost per offset, as houses with higher pre-retrofit energy use have more potential to save more kilowatt hours post-retrofit.

The historical average cost of a carbon offset in the voluntary market is approximately $6/mt$CO_2$e.[26] However, from discussions with other schools, the DCOI has determined that offsets with high co-benefits are generally purchased in the $10-20/mt$CO_2$e range. Overall, the figures above indicate that the current program design produces very expensive carbon offsets and that further changes must be made to streamline the program prior to scaling. Specifically, decreasing the overall cost of the program and increasing the percentage of participants that follow through with retrofits could have a significant impact on the cost per offset.

It is also important to note that the co-benefits from the program are unlike any of the co-benefits currently available through other carbon offsets projects; the program essentially provides an employee benefit in addition to the carbon offsets. Thus, depending on the value of such an employee benefit program to the employer, the total cost of this type of carbon offset program may still be palatable.

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[23] Cost adjusted to reflect a 50% retrofit rate.
[24] Current data shows that on average, houses in the program use energy at a rate slightly above the national average of 11,000 kwh/yr (EIA, https://www.eia.gov/tools/faqs/faq.cfm?id=97&t=3). Since the data from the pilot is currently limited, for these estimates the national average energy use is used for calculations. In addition, to calculate offsets, Duke Energy's emissions factor for energy generation in NC is used.
[25] For the life of the retrofit (10 years)
[26] Forest Trends' Ecosystem Marketplace. Ahead of the Curve: State of the Voluntary Carbon Markets 2015. Available: http://forest-trends.org/releases/uploads/SOVCM2015_FullReport.pdf

Follow-up Survey Results

After the completion of the pilot in February 2016, the DCOI sent out a follow-up survey to all 35 pilot participants to learn more about employee satisfaction with the program as a whole and assess the program's effectiveness in overcoming the barriers to implementing energy efficiency improvements. Of the 20 surveys returned, 19 respondents rated their satisfaction as "Very Satisfied or Satisfied," 19 respondents would recommend this program to a friend or colleague and all 20 participants would participate in the program again.

Many of the participants indicated that the DCOI-HEAL program helped them to overcome their original barriers to participation, specifically the lack of information and lack of trust barriers.

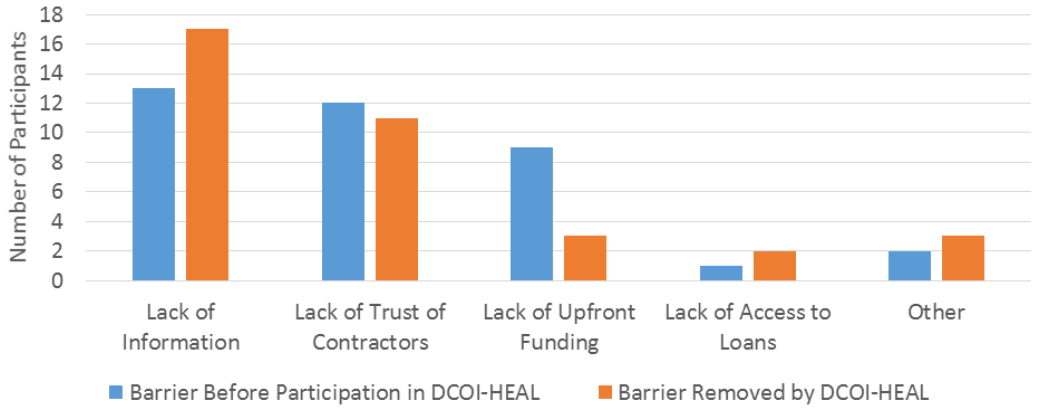

FIGURE 5. BARRIERS TO ENERGY EFFICIENCY IMPROVEMENTS

In addition, many of the improvements that the participants actually made to their homes were not ones they had considered prior to participation in the program. These included some of the 'silent, but impactful' measures like ductwork sealing, air sealing, insulation and crawl space improvements.

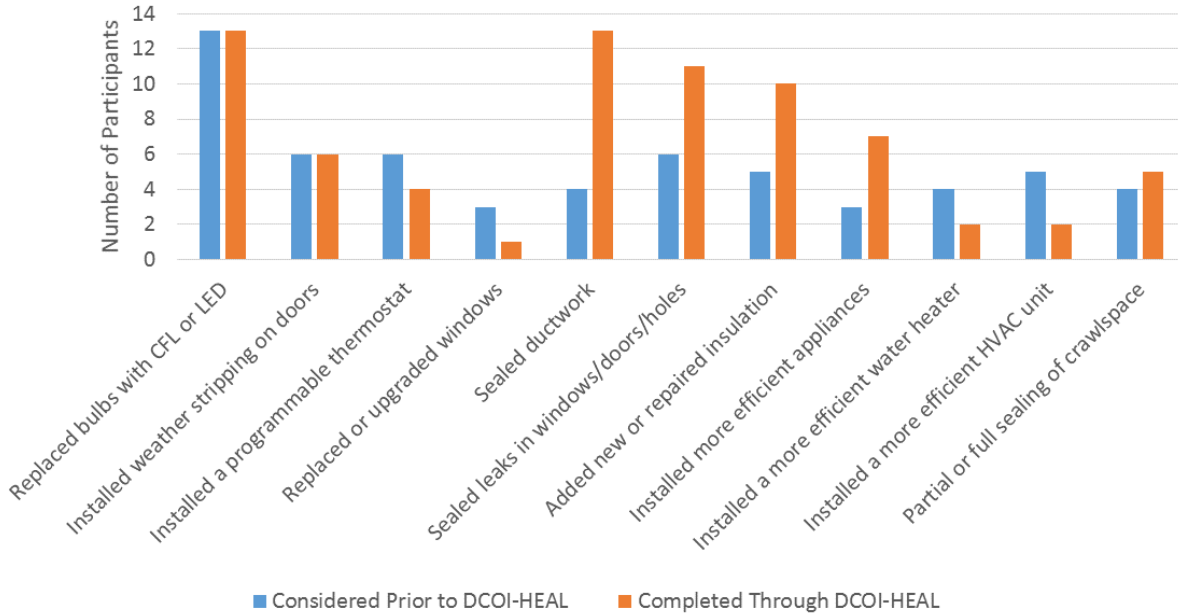

FIGURE 6. ENERGY EFFICIENCY IMPROVEMENTS BOTH BEFORE AND AFTER DCOI-HEAL

Testimonials from Participants

At the end of the survey, the DCOI asked the participants for voluntary testimonials on the program. Among the responses were statements about feelings of empowerment in decision-making and a greater understanding of the benefits of energy efficiency, shared anonymously below:

FIGURE 7. PARTICIPANT TESTIMONIALS

LESSONS LEARNED

The development and implementation of these pilot programs has provided the DCOI with firsthand experience regarding the challenges of executing energy use reduction programs. The following section summarizes a more in-depth discussion of these challenges and lessons learned with potential ways to address them in the future from the DCOI's recent book chapter titled "Leveraging the Employer-Employee Relationship to Reduce Greenhouse Gas Emissions at the Residential Level."[27]

Employee Referrals are Crucial to Program Success

The first round of employees in the DCOI-HEAL program were selected from a sustainability listserv at the university and were highly motivated to join the program and make improvements to their homes. The DCOI-HEAL team found that it was these first round participants that were the most impactful in recruiting participants in future rounds. Positive testimonials about the ease and success of each experience and employee referrals helped to solidify the value of the program and garner trust from future participants.

Do Not Underestimate the Time Constraints to Employees

Despite regular contact with employees with information and guidance, the DCOI-HEAL team was unable to convert all home assessments to actual home retrofits. Due to the complexity and time demands of an effective retrofit program, there are many opportunities for residents to drop out. One solution is to install basic improvements – upgraded lighting, duct sealing and some weatherization – at the time of the home assessment. This provides the resident with directly installed energy efficiency measures during the first interaction and reduces the number of times the employee must be available for retrofit work.

Energy Efficiency Programs are Administratively Time Intensive

The DCOI-HEAL program required significant amounts of time from DCOI staff to schedule audits, summarize audit results, and present results to the employees. The main issue associated with these significant time requirements was the fact that the DCOI staff members involved had other projects to manage in addition to the pilot programs. One way to address this challenge would be to assign one staff member – often called an Energy Advisor – to manage these programs as his or her primary job responsibility. This would prevent time management/prioritization issues, allowing that individual to specialize in and become more efficient at managing the program. Another option would be to use technology, including customer relationship management software, to automate certain parts of the process. Audit scheduling and summaries could both potentially be handled by a web application. Video presentations could be recorded and made available online. Finally, certain parts of the program could be cut out if staff time were limited.

Even a Low-rate, Unsecured Loan Might Not Drive Demand

The DCOI-HEAL program was able to partner with a local credit union to offer a 5.5% unsecured loan for up to $10,000 in energy efficiency improvements. The loan application was streamlined and simple, however only five of the 35 pilot participants used the loan program to fund a home retrofit. While some of the other employees used cash or other loan products such as home equity as a funding source, a few did not believe that the 5.5% rate was low enough to encourage borrowing. In addition, while none of the DCOI-HEAL pilot participants encountered income-qualifying restrictions, there is the potential for a lack of

[27] Leveraging the Employer-Employee Relationship to Reduce Greenhouse Gas Emissions at the Residential Level, Charles Adair, Jennifer Weiss, and Jason Elliott, December 2015.

financing options for income-restricted employees. The use of credit enhancements – a loan loss reserve to protect against defaults or an interest rate buy down – could provide incentives to private lenders to offer and administer lower interest loans to a broader employee base. These options are discussed in the DCOI paper "Financing Energy Efficiency - Based Carbon Offset Projects at Duke University." [28]

Tax Implications of an Employee Benefit Program Drive Program Costs Up

Any benefits provided to employees are potentially subject to federal and state taxes. In the DCOI-HEAL program, paying for the audits was considered supplemental income for employees, increasing their tax burden. To account for this, the DCOI adjusted the benefit in order to pay for the taxes associated and provide a true no-cost audit for pilot participants. This almost doubled the cost of each audit to the DCOI. The DCOI has explored the potential for a third party to provide these benefits to Duke employees, but this framework could still require tax payments on any employee benefits provided. The main strategy to address this challenge is to limit the monetary value of these benefits in order to minimize the cost to the employer. Another option is to require the employee to take on the tax burden, but this may significantly decrease the value of the benefit to the employee.

Energy Efficiency Programs Can be Costly to Implement and Administer

Building on the challenge of tax implications, the monetary cost to implement a program can vary greatly depending on the design of the program. The DCOI-HEAL program costs approximately $1,000 per employee to implement (not taking into account program development costs). Options to reduce this cost include working with a local utility to provide the home assessment portion of the program or sharing the cost of the audit with the employee.

Availability of Qualified Local Contractors Can be Challenging

The DCOI was able to identify a number of high-quality contractors for the DCOI-HEAL program. However, in smaller communities it is common to have a limited number of highly qualified contractors available for these types of programs. In these scenarios, employers may have to work with third parties to train contractors in the area on providing the services required by energy use reduction programs. While this can be resource intensive, it can also provide the employer with the opportunity to help spur economic development and job growth in the region. Another option is for the employer to partner with a national company that provides retrofit services to bring them to the region.

Emissions Reductions are Difficult to Claim

The DCOI collects all energy use reduction data associated with these pilot programs to calculate total emissions reductions. The DCOI hopes to use these emissions reductions to help Duke University reach its climate neutrality goal in 2024. However, state utility policy creates the potential for double counting—the scenario where both the local utility and Duke University count these emissions reductions separately toward their own goals. In this scenario, double counting could lead to fewer emissions reductions overall because the same reductions are counted twice. The DCOI has yet to find a solution to this challenge and will use the energy data collected to continue working to develop one.

[28] http://sustainability.duke.edu/carbon_offsets/resources/Energy%20Efficiency%20Resources/Financing%20Energy%20Efficiency%20Offsets.pdf

RECOMMENDATIONS FOR SCALING UP EMPLOYEE EE PROGRAMS

Employee-based energy efficiency programs provide an excellent opportunity to overcome some of the traditional barriers to energy efficiency investments that many programs have experienced. A trusted employer can provide educational resources, time off to have retrofits completed, and even incentives to ease the financial burden. As a trusted resource, an employer is often in an ideal position to advise an employee on the benefits of energy efficiency improvements. By compiling a comprehensive energy efficiency program offering and aligning with key industry partners, an employer can help to improve an employee's health, comfort and financial situation while simultaneously generating carbon offsets. Based on Duke University's experience in the development of the DCOI-HEAL employee energy efficiency pilot program, the following program elements are key to scaling a program at Duke or replicating the program at other universities and corporate workplaces. As with all benefit programs, the employer must weigh the cost associated with each element and the ultimate benefit to the employee, the community, and the environment.

Educational Resources and Workshops

All employees, not just homeowners, can benefit from education on energy efficiency and conservation. A key to a successful employee energy efficiency program is providing easily accessible educational materials and on-going workshops to encourage employee participation. Games and competitions between departments are also useful for building excitement around efficiency ideas and strategies for reducing energy use at home as well as in the workplace. For a program to be successful over the long term, an employee must be able to quickly find relevant information and be encouraged to ask questions about energy efficiency.

Online Portal to Track Progress and Actual Energy Use Data

To incent employees to learn more about their energy use and help them understand how their energy efficiency measures are performing, a user-friendly online portal can be incorporated to track progress. This portal should summarize a home's actual energy use from utility bills as well as track the improvements made and recommend future improvements. The DCOI-HEAL pilot program utilized an online tool called ResiSpeak to track each employee's energy use before and after home retrofits.[29] This type of tool can also be used to identify other areas for improvement, such as spikes in usage due to a gas leak or behavioral changes like thermostat setbacks.

"Office Hours" to Encourage Questions and Build Momentum

To help build momentum surrounding energy efficiency investments, an employer should offer employees a way to continually interact with program staff – including regularly scheduled "office hours" with an Energy Advisor who can answer questions and reach out to employees to encourage participation. By providing access to a knowledgeable, on-staff individual to answer questions, the employer can utilize the trusted relationship that it has with employees and improve motivation to invest in energy efficiency.

Centralize the Administrative Process

It may be challenging for smaller schools and employers to create and run full employee energy efficiency programs. In these situations, there is the potential for employers within regions to combine their efforts and support a central administrative system that can be shared across employers. Depending on other

[29] https://www.resispeak.com/login

partners in the region, this could be accomplished through the formation of a third party non-profit entity or through partnerships with local utilities.

Energy Efficiency Marketplace

For programs that reside in states or regions with an active energy efficiency market, there is the potential to monetize the results of energy efficiency programs to the benefit of both the employer and the employee. This would not only increase participation in energy efficiency improvements, but would also result in workforce development for contractors and assist private and public companies in meeting their carbon reduction goals. Energy Efficiency Credits and the Clean Power Plan's Emission Rate Credits are two mechanisms for standardizing the emissions reductions created by energy efficiency. The creation of a trading marketplace for these credits would drive demand and provide funding for additional investment into energy efficiency and other clean energy sources. If a region were able to combine this with central administration for employee energy efficiency programs, employers throughout the region could readily scale these programs.

CONCLUSION

The results documented within this paper show that it is possible to build an employee energy efficiency program that removes a significant number of barriers for employees and leads to a high percentage of participants following through with energy efficiency retrofits. In addition, the results show that real energy savings and carbon emissions reductions can be realized through such a program and applied in the future to meet climate policies or goals. Even so, many challenges to scaling this type of program still remain – in particular, the cost per participant.

Building on the success of the DCOI-HEAL pilot program, Duke University will continue to research and implement ways for its employees and community members to make cost-effective investments into energy efficiency. The DCOI has received funding from The Duke Endowment to build a series of energy conservation and efficiency educational workshops that will be available to all Duke employees. The goal of these workshops is to provide employees with an "on-ramp" to energy efficiency, helping them build momentum by learning about basic behavioral changes and energy efficiency retrofits. Through surveys, pilot programs, and discussions with other employers, the University will continue to refine its energy efficiency strategy towards achieving its carbon neutrality goals.