

STATE OF NORTH CAROLINA
UTILITIES COMMISSION
RALEIGH

DOCKET NO. E-2, SUB 1273

BEFORE THE NORTH CAROLINA UTILITIES COMMISSION

In the Matter of)	
Application of Duke Energy Progress, LLC)	REBUTTAL TESTIMONY OF
for Approval of Demand-Side Management)	ROBERT P. EVANS FOR
and Energy Efficiency Cost Recovery Rider)	DUKE ENERGY PROGRESS,
Pursuant to N.C. Gen. Stat. § 62-133.9 and)	LLC
Commission Rule R8-69)	

1 **Q. PLEASE STATE YOUR NAME, BUSINESS ADDRESS, AND**
2 **POSITION WITH DUKE ENERGY.**

3 A. My name is Robert P. Evans, and my business address is 410 S. Wilmington
4 Street, Raleigh, North Carolina. I am employed by Duke Energy Corporation
5 as Senior Manager-Strategy and Collaboration for the Carolinas in the
6 Integrated Grid Strategy and Solutions group.

7 **Q. DID YOU PREVIOUSLY FILE DIRECT TESTIMONY IN SUPPORT**
8 **OF DUKE ENERGY PROGRESS, LLC'S ("COMPANY")**
9 **APPLICATION IN THIS DOCKET?**

10 A. Yes.

11 **Q. WHAT IS THE PURPOSE OF YOUR REBUTTAL TESTIMONY?**

12 A. The purpose of my rebuttal testimony is to respond to portions of the testimony
13 of Forest Bradley-Wright, filed on behalf of the North Carolina Justice Center
14 ("NCJC"), the North Carolina Housing Coalition, and the Southern Alliance for
15 Clean Energy ("SACE") and to portions of the testimony of Michael C. Maness,
16 filed on behalf of the Public Staff of the North Carolina Utilities Commission
17 ("Public Staff").

18 **Q. WILL YOU DESCRIBE THE PORTIONS OF WITNESS BRADLEY-**
19 **WRIGHT'S TESTIMONY TO WHICH YOU ARE RESPONDING?**

20 A. Yes. There are several portions of witness Bradley-Wright's testimony that
21 cause concerns; specifically, those portions related to the one percent ("1%")
22 savings target, the Company's low-income energy efficiency program budgets,
23 the request for the quantification of carbon savings resulting from demand-side

1 management and energy efficiency programs, and his remarks regarding the
2 Market Potential Study.

3 **Q. PLEASE DESCRIBE YOUR CONCERNS RELATED TO THE**
4 **PORTIONS OF WITNESS BRADLEY-WRIGHT'S TESTIMONY**
5 **DISCUSSING THE ASPIRATIONAL GOAL OF SAVING 1% OF THE**
6 **PRIOR YEAR'S RETAIL SALES FROM ENERGY EFFICIENCY AND**
7 **DEMAND-SIDE MANAGEMENT PROGRAMS.**

8 A. The 1% target that witness Bradley-Wright refers to as the key feature of the
9 Settlement Agreement among DEP, Duke Energy Carolinas, LLC ("DEC"), the
10 Natural Resources Defense Council, SACE, the North Carolina Sustainable
11 Energy Association, the North Carolina Attorney General's Office and the
12 Public Staff is not an express requirement of the Settlement Agreement.¹ It is,
13 instead, an aspirational goal. That being said, the source of the aspirational 1%
14 goal was a 2011 Settlement Agreement between and among the Environmental
15 Defense Fund, the South Carolina Coastal Conservation League and SACE,
16 filed in the South Carolina Public Service Commission proceedings on the
17 merger of Duke Energy Corporation and Progress Energy, Inc., as witness
18 Bradley-Wright testified to in Docket No. E-2, Sub 1206.² That Settlement
19 Agreement covered a multi-year period that ended in 2018.

¹ Witness Bradley-Wright's testimony includes the South Carolina Coastal Conservation League and Sierra Club as parties to the Settlement Agreement, but under the Commission's October 20, 2020 *Order Approving Revisions to Demand-Side Management and Energy Efficiency Cost-Recovery Mechanism*, issued in Docket Nos. E-2, Sub 931 and E-7, Sub 1032, SCCCL and Sierra Club were parties only to the Duke Energy Carolinas, LLC Settlement Agreement in Docket No. E-7, Sub 1032.

² See Docket No. E-2, Sub 1206, Tr. p. 186 (Witness Bradley-Wright responding to questions from counsel after the Commission's questions). The merger-related Settlement Agreement referred to was filed in Docket Nos. 2011-68-E and 2011-158-E on December 13, 2011.

1 The Company takes achieving this 1% savings aspiration goal very
2 seriously and continues to work with stakeholders and within N.C. Gen. Stat. §
3 62-133.9, the Commission Rules, and the Mechanism toward developing cost-
4 effective and marketable energy efficiency (“EE”) and demand-side
5 management (“DSM”) programs that will result in energy savings for their
6 customers. Under the Mechanism approved by the Commission, the Company
7 is rewarded for achieving that goal. Achieving that aspirational goal for DEP,
8 however, has been hindered by the number of opt out customers in the DEP
9 North Carolina service territory, as compared to DEC’s service territory.
10 Additionally, a lack of clarity on how eligible non-residential customers
11 electing to opt out of participating in the Company’s EE/DSM portfolio of
12 programs, as allowed under N. C. Gen. Stat. § 62-133.9(f), impacts the
13 calculation of the energy savings that DEP has achieved.

14 **Q. PLEASE EXPLAIN HOW THE STATUTORY OPT OUT PROVISION**
15 **IN NORTH CAROLINA GEN. STAT. § 62-133.9(f) IMPACTS WITNESS**
16 **BRADLEY-WRIGHT’S ASSERTION THAT THE COMPANY HAS**
17 **NOT MET THIS ASPIRATIONAL GOAL.**

18 A. Witness Bradley-Wright does not appear to make an “apples to apples”
19 comparison. The percentage of savings as calculated by Bradley-Wright
20 reflects the energy savings achieved through the Company’s energy efficiency
21 and demand-side management (“EE/DSM”) programs compared to the total
22 retail sales of the Company, including the sales to customers that have opted
23 out of, and therefore are not eligible to save energy through the Company’s

1 EE/DSM programs. In other words, there is a disconnect between the
2 numerator and denominator used in witness Bradley-Wright's calculation of the
3 percentage used to determine the Company's attainment.

4 **Q. WHY SHOULD OPT-OUT ASSOCIATED SALES BE REMOVED**
5 **FROM TOTAL SALES TO CALCULATE THE PERCENTAGE**
6 **SAVINGS?**

7 A. To reflect a true apples to apples comparison, the opt-out associated sales
8 should also be removed in the calculation of the savings goal. DEP has a
9 significant portion of its non-residential sales to industrial and commercial
10 customers that have opted out of the Company's EE/DSM portfolio. These
11 customers do not impact the level of recognized savings even though those
12 customers utilize their own energy efficiency programs. The proper formula to
13 use in determining savings that are actually subject to Company control is
14 *(Savings from Company Programs)/((Total Sales) – (Opt-Out Sales))*. More
15 simply put, calculating the energy savings percentage while including an energy
16 sales number increased by sales to opt-out customers, does not accurately
17 reflect the success of the EE programs reducing energy usage from the customer
18 sales that can be impacted by the programs.

19 **Q. WHAT CONCERNS DO YOU HAVE WITH WITNESS BRADLEY-**
20 **WRIGHT'S TESTIMONY RELATING TO THE COMPANY'S**
21 **ENERGY EFFICIENCY PROGRAMS FOR LOW-INCOME**
22 **CUSTOMERS?**

23 A. I have two concerns. The first is his recommendation that the Commission
24 direct DEP to increase its low-income energy efficiency program budgets to at

1 least match those of DEC on a per-residential customer basis. The second is
2 his omission of pertinent information regarding the Durham Pilot Program.

3 **Q. WHAT CONCERNS DO YOU HAVE WITH WITNESS BRADLEY-**
4 **WRIGHTS TESTIMONY RELATING TO ADJUSTING THE**
5 **COMPANY'S BUDGET FOR LOW-INCOME PROGRAMS?**

6 A. Witness Bradley-Wright's budgetary recommendations appear to continue to
7 be based on the misconception that increasing a projected budget for an energy
8 efficiency program will automatically increase the participation in a EE/DSM
9 program and thereby result in increased energy savings. The Company has tried
10 to address this misconception multiple times and has explained that a program
11 budget is not a *ceiling* on spending, but rather an attempt to accurately reflect
12 the costs associated with projected participation in a program for the purposes
13 of cost recovery from customers. Higher projected budgets result in higher
14 projected costs to be recovered from customers through the EE/DSM rider. The
15 past performance of the Company's EE/DSM portfolio has demonstrated many
16 times that if additional program spending above a projected budget is necessary
17 to meet customer participation, the Company's spending will exceed the
18 budget. After Commission review and approval, the Company may then
19 recover the overspend when the vintage year of that program is trued up. Low-
20 income programs are no different. Rather than simply projecting an arbitrary
21 and unsubstantiated increase to the budget, the Company is actively working
22 with SACE and other stakeholders to develop pilot programs targeting low-
23 income customers that will justify additional spending associated with
24 projected participation.

1 **Q. PLEASE DESCRIBE THE DURHAM PILOT PROGRAM.**

2 A. The Durham Pilot Program was a limited weatherization assistance program for
3 low-income customers. Notably the Durham Pilot Program's scope was only
4 206 homes. Participants also received supplemental Helping Home Funds to
5 address health, safety, and incidental repair needs prior to efficiency
6 improvements. The Company is proud of the Helping Home Fund's work and
7 Duke Energy Carolinas, LLC's work on the Durham Pilot, but neither is an
8 approved EE program under Commission Rule R8-68.

9 **Q. WHAT PERTINENT INFORMATION DOES WITNESS BRADLEY-**
10 **WRIGHT'S TESTIMONY OMIT WHEN DESCRIBING THE DURHAM**
11 **PILOT?**

12 A. Starting on line 20 of page 29 of his testimony, witness Bradley-Wright quotes
13 from the Opinion Dynamics Evaluation, Measurement, and Verification report
14 associated with the Durham Pilot (attached for the Commission's convenience
15 hereto as Exhibit 1). He states the following:

16 [A] program design similar to the Durham Pilot could be a good
17 option for bringing weatherization services to customers in South
18 Carolina and/or the DEP service territory.

19 To put this in context, on page 43 of the same report, Opinion Dynamics also
20 indicated that "Finally, the funding approach of covering the full project cost
21 without contributions by agencies might make this program design *difficult to*
22 *implement on a larger scale.*" (Emphasis added.) Opinion Dynamic's report
23 further states on page 47 that "[s]ince this evaluation did not include a formal
24 impact assessment, however, more rigorous impact analysis would be required

1 to quantify the savings of the Durham Pilot. ”

2 **Q. DO YOU AGREE WITH WITNESS BRADLEY WRIGHT’S POSITION**
3 **REGARDING THE QUANTIFICATION OF CARBON SAVINGS?**

4 A. No, I do not agree.

5 **Q. WHAT ARE YOUR CONCERNS WITH RESPECT TO THE**
6 **QUANTIFICATION OF CARBON SAVINGS IN DEP’S EE/DSM**
7 **PROCEEDINGS?**

8 A. Because there are no recognized financial impacts within the EE/DSM
9 mechanism associated explicitly with carbon savings, such a quantification is
10 outside the scope of DEP’s filing for approval of its EE/DSM rider under
11 Commission Rule R8-69 at this time. As such, the tracking and reporting on
12 carbon savings in the Company’s EE/DSM cost recovery filings is unnecessary
13 in this proceeding and would likely result in added costs to customers to be
14 recovered through the EE/DSM rider.

15 **Q. WHAT ARE YOUR CONCERNS WITH RESPECT TO WITNESS**
16 **BRADLEY-WRIGHT’S REMARKS CONCERNING THE MARKET**
17 **POTENTIAL STUDY (“MPS”)?**

18 A. Witness Bradley-Wright indicated that the Company’s reliance on the Total
19 Resource Cost (“TRC”) instead of the Utility Cost Test (“UCT”) for its MPS
20 substantially undercounted the economic savings potential. There are several
21 flaws with witness Bradley-Wright’s contention. First, the MPS was completed
22 prior to the UCT replacing the TRC test as the screen for cost-effective EE/DSM
23 programs. The UCT goes into effect as the screen in 2022. Second, although
24 the MPS is used to inform program offerings, it is not a direct input into the

1 energy savings in the Company's 2022 projection in this proceeding. Witness
2 Bradley-Wright's concerns regarding the MPS and the impact of utilizing the
3 TRC versus UCT for planning purposes is more appropriate in the Company's
4 integrated resource planning proceedings, rather than in this annual rider
5 proceeding under Commission Rule R8-69. Third, the Company addressed this
6 concern in its Collaborative. As part of the specific Collaborative discussion
7 addressing concerns around the MPS, the Company explained that Nexant, who
8 developed the MPS, applied the TRC test to the Economic Potential Screen, but
9 also included a sensitivity to calculate an Economic Potential using the UCT
10 screen, which resulted in an increase to the Economic Potential. While applying
11 UCT does increase economic potential, it was not appropriate to utilize in the
12 determination of the achievable potential, which recognizes market barriers to
13 participation. This decision was grounded in a firm understanding of the cost
14 effectiveness screens and the nature of each of these tests. The UCT considers
15 the economics from the utility's perspective, not from that of the customer. The
16 TRC test recognizes the customer's out-of-pocket cost and, as such, the
17 customer's economics associated with the adoption of energy efficiency
18 measures. Therefore, the TRC test is a better vehicle from which to assess the
19 achievable potential of energy efficiency measures in MPS.

20 **Q. HOW DO YOU RESPOND TO PUBLIC STAFF WITNESS MANESS'S**
21 **RECOMMENDATION ON REFINING THE ACCOUNTING RELATED**
22 **TO COSTS FOR THE FIND IT DUKE REFERRAL CHANNEL?**

23 A. Consistent with the Commission's September 10, 2021 *Order Approving*
24 *DSM/EE Rider and Requiring Filing of Proposed Customer Notice*, issued in

1 Docket No. E-7, Sub 1249, which applied to Duke Energy Carolinas, LLC,
2 Duke Energy Progress is also working to identify and quantify the applicable
3 non-energy efficiency related referral costs and revenues in the Find it Duke
4 referral channel, so that they may be removed from the Company's requested
5 cost recovery in this proceeding. The Company will also review and, if
6 appropriate, discuss the impact of the Commission's decision on the Find It
7 Duke referral channel with the Public Staff prior to Duke Energy Carolinas,
8 LLC's or the Company's next DSM/EE annual rider proceeding filing.

9 **Q. DOES THIS CONCLUDE YOUR REBUTTAL TESTIMONY?**

10 **A. Yes.**



Opinion **Dynamics**

Evans Rebuttal Exhibit 1
Docket No. E-2, Sub 1273

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Sep 16 2021



Duke Energy Carolinas

Low Income Weatherization Program (2016–2018)

Evaluation Report – Final

April 16, 2021



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1. Evaluation Summary

This report presents findings from our impact and process evaluation of the Duke Energy Carolinas (DEC) Low Income Weatherization Program (hereafter referred to as the Weatherization Program or the program), covering the period of April 2016 to December 2018. The impact evaluation results are based on a combination of billing analysis and engineering analysis. Process evaluation results are based on a program materials review, interviews with program staff and participating agencies, and a telephone survey of program participants. In addition, this report includes a limited process evaluation of the new DEC Weatherization Pilot in Durham, North Carolina, based on an in-depth interview with pilot program staff and a program materials and tracking data review.

This report includes a high-level description of the evaluation methodologies as well as results, findings, and recommendations. The associated appendix includes additional detail on the impact methodology and results.

1.1 Program Summary

The Weatherization Program aims to improve the health, safety, and energy efficiency of income-qualified Duke Energy customer households by leveraging existing weatherization programs to provide a comprehensive package of electric conservation measures at no cost to DEC customers. Duke Energy's implementation partners are the program administrator (the North Carolina Community Action Association, or NCCAA); the database administrator (TRC; previously Lockheed Martin); and a network of local implementing agencies that include community action agencies (CAAs), local governments, and other nonprofit organizations that enroll customers and complete weatherization projects. DEC initially designed the program to leverage federally funded state weatherization assistance programs (State WAPs), in which implementing agencies already participate. DEC pays a fixed price per State WAP project completed at qualifying DEC customer's homes, with the requirement that agencies then use the funds to support future weatherization-related activities. In an effort to bypass strict DOE program funding rules and to encourage more participation in South Carolina, DEC introduced a new participation channel in 2018 in which agencies could submit qualifying weatherization projects originally funded from their operating budget or another source.

Weatherization Program participants must live in an individually metered single-family home with a household income less than or equal to 200% of the federal poverty guideline. The Weatherization Program offers two participation tiers for owner-occupied homes, as well as a refrigerator replacement offering to both owners and renters (with landlord approval). Tier I covers eligible projects at homes using less than 7 kWh per square foot annually and provides up to \$600 for air sealing and low-cost energy efficiency upgrades like LEDs, domestic water heater tank insulation, low-flow shower heads, faucet aerators, and others. Tier II covers eligible projects at homes using at least 7 kWh per square foot annually and provides up to \$4,000 for Tier I measures plus insulation improvements. Tier II projects can qualify for a higher funding cap of \$6,000 if they include a qualifying heat pump upgrade or replacement. Refrigerator replacement is available even if the home did not receive any Tier I or Tier II measures. Refrigerator replacement eligibility and incentive levels are dependent on the old refrigerator's size and a two-hour metering test.

1.2 Evaluation Objectives

We established the following objectives for this evaluation:

- Review and update, as necessary, deemed savings estimates through a review of measure assumptions and calculations;

- Verify measure installation and persistence;
- Estimate program energy (kWh) and summer and winter peak demand (kW) savings;
- Determine participants' level of satisfaction with the program and measures received;
- Identify non-energy benefits realized by participants;
- Identify barriers to agency participation in the program and recommend strategies for addressing those barriers;
- Identify program strengths and potential ways that the program can increase average savings per household; and
- Compare the program design, participation levels, and savings potential of the Weatherization Program to early achievements of DEC's Durham Low Income Weatherization Pilot to assess Pilot performance and potential for savings.

To achieve these objectives, we completed a number of data collection and analytic activities:

- Impact evaluation activities included a review of program-tracking data, a deemed savings review, development of in-service rates (ISRs), an engineering analysis, and a consumption analysis.
- Process evaluation activities included a review of program materials; interviews with Duke Energy program staff, implementing agency staff, NCCAA and TRC staff, and Durham Pilot program managers; and a survey of participating customers.

1.3 High Level Findings

During the evaluation period, 1,706 households participated in the Weatherization Program, completing over 2,000 projects. The majority of participants (81%) completed a Tier II project; only 10% of participants completed a Tier I project. In addition, 24% received a replacement refrigerator, either as a stand-alone measure (8%) or in combination with Tier I or Tier II services (15%).

Impact Findings

Based on our impact analysis, we estimate that the projects completed during the evaluation period generate close to 3.2 million kWh of annual energy savings, 539 kW of annual summer coincident demand savings, and 935 kW of annual winter coincident demand savings. Tier II participants account for the largest share to program-level savings (89%) while Tier I participants and refrigerator replacements account for 1.3% and 9.6%, respectively, of total program energy savings.

Table 1 presents annual per-household and program-level net ex post savings for the evaluation period.

Table 1. Summary of Impact Results

Project Type	Number of Participants	Net Annual Savings Per Household			Net Annual Program Savings		
		Energy (kWh)	Summer Coincident Demand (kW)	Winter Coincident Demand (kW)	Energy (kWh)	Summer Coincident Demand (kW)	Winter Coincident Demand (kW)
Tier I	176	241	0.0724	0.0416	42,398	12.7	7.3
Tier II	1,387	2,042	0.3544	0.6438	2,832,531	491.5	892.9
Refrigerator Replacement	404	758	0.0864	0.0864	306,097	34.9	34.9
Total ^a	1,706				3,181,027	539.2	935.2

^a The total number of unique participants is smaller than the sum of project types since some households complete more than one project.

Based on program-tracking data, almost all Tier I and Tier II participants (96% and 97%, respectively) received air sealing. The vast majority (91%) of Tier II participants also received insulation, and 74% received duct system sealing or insulation—measures not offered to Tier I participants. Larger shares of Tier II participants than Tier I participants received water heating measures, weatherstripping, lighting, and heating system tune-ups. Overall, 24% of participants received a new refrigerator and 19% an HVAC replacement or upgrade. Notably, 8% of participants only received a new refrigerator and 14% only received an HVAC replacement/upgrade.

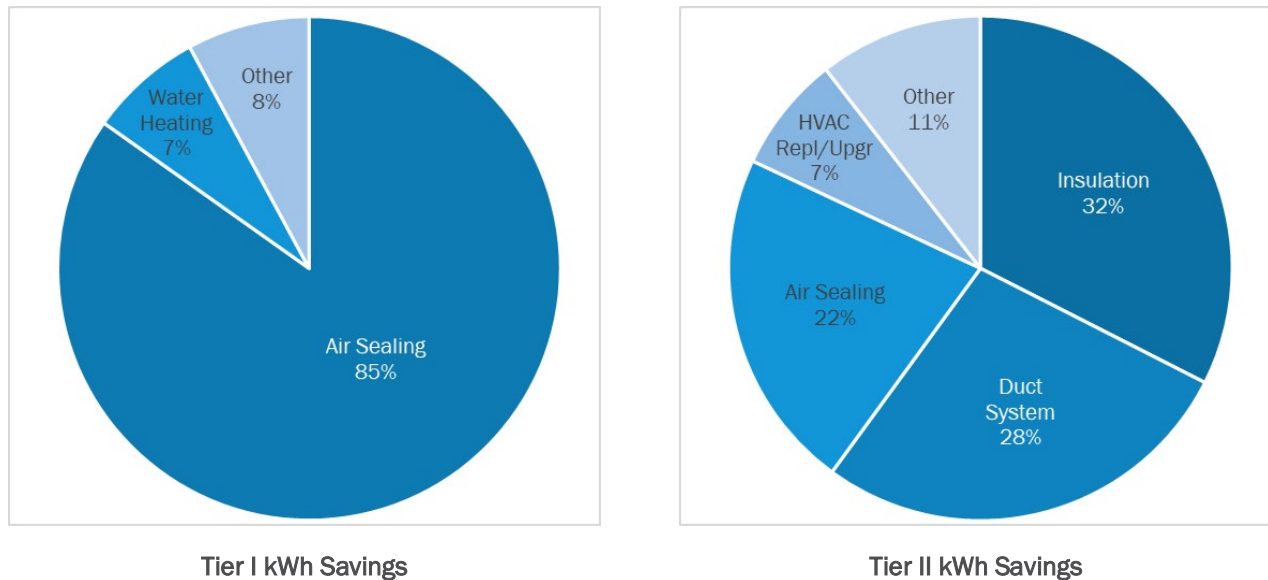
Table 2. Measure Mix

Measure Category	% of Participating Households Receiving Measure Category ^a		
	All Participants (N=1,706)	Tier I Participants (N=176)	Tier II Participants (N=1,146)
Air Sealing	75%	96%	97%
Insulation	61%	n/a	91%
Duct System	50%	n/a	74%
Water Heating	50%	31%	70%
Weatherstripping	43%	35%	59%
Lighting	26%	26%	35%
Heating System Tune-Up	19%	6%	27%
Refrigerator Replacement	24%	19%	17%
HVAC Replacement/Upgrade	19%	1%	7%

^a Values are based on program-tracking data and do not incorporate ISRs.

Based on the engineering analysis, Tier I savings during the evaluation period came primarily from air sealing (85%). Another 7% came from water heating measures and 8% came from other Tier I measures (including heating system tune-ups, lighting measures, and weather-stripping). Tier II savings, on the other hand, were dominated by insulation (32%), duct sealing and insulation (28%), and air sealing (22%). HVAC replacements/upgrades accounted for 7% of engineering-based Tier II savings during the evaluation period, while other Tier II measures (including water heating measures, heating system tune-ups, lighting, and weather-stripping) contributed 11% (see Figure 1).

Figure 1. Measure Contribution to Total Tier I and Tier II Energy Savings



Process Findings

The process evaluation found that the DEC Weatherization Program continues to benefit from previously established relationships, implementation processes, and program-tracking systems. Program and implementation staff reported no major changes to the program since the previous evaluation aside from the new participation channel established in 2018. Participating agencies also reported minimal changes to how they implement and participate in the Weatherization Program, and many reported the DEC funds allow them to complete more weatherization jobs than they would have otherwise.

Key process findings include:

- **Program Participation.** Participation in the Weatherization Program has been increasing steadily since the program began in 2015. Agencies work hard to inform clients about the program through multiple advertising channels (newspaper ads, in-person events, agency websites, etc.) and half of interviewed agencies indicated the number of projects they complete each year is increasing.
- **New Participation Channel.** Prior to 2018, agencies could only submit projects originally funded by the State WAP for reimbursement from Duke Energy. Now, agencies may submit for reimbursement projects they originally funded through their operating budget or another source. This opened the possibility of non-CAA organizations, such as non-profit organizations, to participate in the program and bring Weatherization Program services to their clients. Half of the agencies we interviewed indicated they had used this new participation channel. One agency, a non-profit organization, indicated they used this participation channel exclusively and only performed refrigerator replacements since their organization was not equipped to perform more extensive weatherization on clients' homes.
- **Satisfaction.** The process evaluation showed high satisfaction with the Weatherization Program. Interviewed agency staff often provided unprompted praise for the program implementation team and underscored the importance of the program to their clients. Agencies found the logistical elements of the program—including program organization, communication, and reporting—to be key program

strengths. Participants were also highly satisfied with the program overall. A key concern for participants is high energy bills, and survey results suggest the program is helping participants in this respect, with 73% and 58% of respondents reporting lower summer and winter electricity bills, respectively, following participation in the program.

- **Non-Energy Impacts.** In addition to lowering energy bills, the Weatherization Program provides substantial non-energy benefits to participants including improved home comfort in the summer and winter, reduced draftiness, and better lighting. To a lesser extent, survey respondents also reported lower outdoor noise levels and home maintenance costs, improved quality of life, safer homes, and increased water efficiency.
- **South Carolina Policy Barriers.** Despite the new participation channel—introduced in 2018 to encourage participation by South Carolina agencies—barriers to program participation remain high in South Carolina, and no projects were completed in the state during this evaluation period. While the new participation channel has not yet resulted in program participation in the state, program staff continue to conduct outreach and provide additional support to South Carolina agencies and to encourage future program participation.
- **Durham Pilot.** Between October 2018 and December 2019, Duke Energy offered a weatherization pilot in Durham, North Carolina, which served a total of 206 customers. One goal of this pilot was to determine if the current DEC Weatherization Program design and funding model could be improved to expand program services to South Carolina and into the Duke Energy Progress (DEP) service territory. The limited process evaluation of the Durham Pilot found key differences between the pilot and the Weatherization Program in program eligibility, implementation, and measure mix:
 - Not relying on agencies to implement the program made the Durham Pilot implementation smoother and more flexible, and access to customer data allowed Pilot staff to target the program to the customers who needed it most. Since the Durham Pilot was entirely funded by DEC, participants did not need to spend time completing federal or state assistance program applications, which greatly reduced administrative burden on participants.
 - Compared to DEC Weatherization projects in the evaluation period, Durham Pilot projects were more likely to include both weatherization measures and an HVAC upgrade. Additionally, Durham Pilot participants were more likely to receive a refrigerator replacement. Based on the measure mix, we believe that the Durham Pilot has the potential to provide per household savings on par with, or possibly greater than, the savings estimated for the DEC Weatherization Program. Since this evaluation did not include a formal impact assessment, however, more rigorous impact analysis would be required to quantify the savings of the Durham Pilot.

Overall, pilot staff were highly satisfied with the performance of the pilot and indicated that participants were particularly grateful for program services they may have otherwise waited years to receive. Given the continuing policy barriers in South Carolina, despite the new participation channel, a program design similar to the Durham Pilot could be a good option for bringing weatherization services to customers in South Carolina and/or the DEP service territory.

1.4 Evaluation Recommendations

We have developed the following recommendations based on the results of our evaluation:

- **Consider tracking several additional parameters within the program-tracking system, if feasible, to enhance the accuracy of future deemed savings estimates.** Our deemed savings review (see Appendix B) identified a few parameters that are currently not tracked in program data: (1) pre- and post- blower door results in units of reduced cubic feet per minute (CFM); (2) presence or type of cooling at participating homes; (3) water heating fuel of participating homes; and (4) the installed location (e.g., bathroom, kitchen) for each low-flow faucet aerator. Some of this information is currently collected in the participant survey but having it in the program-tracking data for the population of participants would enhance the accuracy of future deemed savings estimates. We therefore recommend asking weatherization agencies to enter this information into the program's tracking system, if available.
- **Consider changing the reimbursement structure or increase reimbursement amounts.** The current Tier II incentive structure provides up to \$6,000 for Tier II projects. TRC and NCCAA indicated that agencies may struggle covering the cost of HVAC replacements with the current reimbursement amount, which has not increased since the program began in 2015. In addition, this reimbursement cap may also prevent participants from receiving weatherization services in addition to HVAC replacements/upgrades: Based on program-tracking data, only 6% of Tier II projects include both HVAC replacements/upgrades and other Tier II measures, compared to 34% in the Durham Pilot, which provided higher incentives. Agencies may be able to provide additional energy saving measures in Tier II homes, leading to deeper savings, if the overall Tier II incentive amount was increased.
- **Increase support to agencies in program marketing and outreach.** Agencies noted that communication and organization of the program were key strengths and frequently provided unprompted praise for staff at Duke Energy and NCCAA. One area agency identified for potential additional Duke assistance was marketing and outreach to help increase customer awareness of the program. This could be through information about the program on customer bills or on Duke Energy's website, or by developing testimonials from past program participants with examples of bill savings and other benefits—such as non-energy impacts (NEIs) reported by many surveyed participants—derived from their weatherization projects.
- **Explore options to increase the uptake of comprehensive weatherization projects through the new participation channel.** The new participation channel allows non-profit and other organizations to provide program services to customers who may not have been able to receive them otherwise. One objective of this channel was to overcome barriers to participation in South Carolina, as State policies prevent CAAs from participating in the program. Based on program-tracking data through April 2020, however, the new channel has not been successful in encouraging South Carolina organizations to participate in the program. In addition, information from our agency interviews suggest that some non-CAAs may not be equipped to facilitate the implementation of weatherization projects and thus limit their activity to equipment replacement. The program should continue to explore ways to promote participation in South Carolina, by identifying suitable partner organizations (with prior weatherization expertise) and/or providing non-CAA organization with additional support in implementing weatherization services.
- **Consider expanding the Durham Pilot to include the South Carolina service territory.** Given the substantial policy barriers that continue to block participation in South Carolina, one way to provide weatherization upgrades to South Carolina customers is to introduce a program design similar to the Durham Pilot. Based on our review of project types and measures installed through the pilot, the

Evaluation Summary

savings potential for a program design similar to the pilot appears to be on par with, or even greater than, savings observed for the Weatherization Program. In addition, pilot participants and staff were very satisfied with the experience, and there were very few implementation challenges. If policy barriers persist, or the new participation channel fails to increase participation in South Carolina, this may be an option to expand services in the state.

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2. Program Description

This section describes key elements of program design, implementation, and performance. The evaluation period addressed in this report is April 1, 2016 through December 31, 2018. This is the second evaluation of the DEC Weatherization Program; the first evaluation covered the period of February 1, 2015 through March 31, 2016.

2.1 Program Design

The Weatherization Program aims to improve the health, safety, and energy efficiency of income-qualified Duke Energy customer households. The program does so by providing customers with comprehensive home weatherization services and repairs that reduce electric energy consumption. The program distributes funding through a network of CAAs and other similar organizations (collectively referred to as “agencies”), which serve Duke Energy’s residential electric customers. The program reimburses agencies for work completed at eligible homes.

The DEC Weatherization Program offers two tiers of funding for weatherization upgrades to owner-occupied homes, as well as refrigerator replacements to both homeowners and renters (with landlord approval). Tier I covers eligible projects at homes using less than 7 kWh per square foot annually and provides up to \$600 for air sealing and low-cost energy efficiency upgrades like LEDs, domestic water heater tank insulation, low-flow shower heads, faucet aerators, and others. Tier II covers eligible projects at homes using at least 7 kWh per square foot annually and provides up to \$4,000 for Tier I measures plus insulation improvements. Tier II projects can qualify for a higher funding cap of \$6,000 if they include a qualifying heat pump upgrade or a heat pump system replacement. Refrigerator replacement is available even if the home did not receive any Tier I or Tier II measures. Refrigerator replacement eligibility and incentive levels are dependent on the old refrigerator’s size and a two-hour metering test.

In 2018, the program introduced a new participation channel, which broadened the type of organizations that can participate in the program and the funding sources for projects. Prior to this change, only CAAs were eligible to participate, and they could only submit qualifying DOE/State WAP projects for reimbursement. Now, other organizations, such as non-profits, are also eligible to submit projects, and the projects do not have to be DOE/State WAP projects but could be funded from the organization’s operating budget or another funding source. DEC made this change to offer an alternative participation channel that can work within the strict DOE guidelines in South Carolina.

2.2 Program Implementation

During the evaluation period, DEC contracted with NCCAA and their subcontractor TRC to implement the Weatherization Program. In total, 15 local agencies participated in the program—including CAAs, local and regional government offices, and other non-profit organizations. These agencies also implement a variety of poverty relief activities, including the State WAP. NCCAA and TRC oversee agency submittals, invoicing, and program-tracking; train agencies on the program and requirements; support participating agencies in making the most of program funding; and conduct outreach to potential new agencies.

2.3 Program Performance

During the evaluation period the program served 1,706 unique households. The majority of participants (81%) completed a Tier II project. Only 10% of participants completed a Tier I project and 24% received a replacement

Program Description

refrigerator. Based on the impact analysis, the program achieved average annual savings of 241 kWh per Tier I participant and 2,042 kWh per Tier II participant. Refrigerator recipients saved an additional 758 kWh per year. Table 3 summarizes program participation as well as per household energy and demand savings, by project type.

Table 3. Annual Per Household Savings

Project Type	Number of Participants	Net Annual Savings Per Household		
		Energy (kWh)	Summer Coincident Demand (kW)	Winter Coincident Demand (kW)
Tier I	176	241	0.0724	0.0416
Tier II	1,387	2,042	0.3544	0.6438
Refrigerator Replacement	404	758	0.0864	0.0864
Total ^a	1,706			

^a The total number of participants is greater than the sum of project types since some households complete more than one project.

3. Overview of Evaluation Activities

3.1 Program Staff Interviews

We conducted in-depth interviews with Duke Energy program staff (supporting both the DEC Weatherization program and Duke's Durham Weatherization Pilot) and the DEC Weatherization Program administrator. The main purpose of each interview was to gain insight into program implementation processes and to develop research objectives for the evaluation. In particular, the interviews allowed us to identify consistencies and inconsistencies across the program, processes that are working well, and processes that could be improved moving forward.

3.1.1 Duke Energy Program Staff Interview

Opinion Dynamics conducted an in-depth interview with the DEC Weatherization Program manager in November 2019. The purpose of the interview was to gauge changes in program design and implementation since the last evaluation, and DEC's current expectations for the Weatherization Program, including the program's goals, successes, and challenges over the evaluation period. The interview also covered changes to the program's measure mix, agency participation, and barriers to program participation.

3.1.2 Program Administrator Staff Interview

We conducted one in-depth interview with NCCAA (the program administrator) and its subcontractor TRC. TRC maintains the program-tracking database and serves as the day-to-day contact for agencies, providing them with training and implementation support. This interview explored program-wide coordination, delivery, and enrollment processes. It provided insight into the program's reimbursement process and gauged the administrators' satisfaction with program elements. The interview also helped identify key similarities and differences across implementing agencies and any barriers to agency participation.

3.1.3 Duke Energy Durham Weatherization Pilot Staff Interview

As part of our limited process evaluation of the DEC Weatherization Pilot program in Durham, NC, we conducted one interview with the DEC Weatherization Pilot program manager and community outreach manager. The objective of the interview was to document the program design of the pilot, identify early implementation successes and challenges, and enable comparisons to the Weatherization Program.

3.2 Implementing Agency Staff Interviews

Fifteen agencies, all located in North Carolina, submitted projects to the DEC Weatherization Program during the evaluation period. These agencies each received funding for an average of 136 projects (range: 1 to 746 projects per agency). We conducted semi-structured in-depth interviews with a sample of six of the 15 participating agencies selected to represent varied types of organizations and levels of program participation. We explored changes to the program since the last evaluation, feedback on implementation processes and funding structure, as well as agencies' satisfaction with the program and views about successes and barriers to participation.

We completed these interviews in June and July 2020. Responding agencies completed 82% of the 2016–2018 projects. Table 4 summarizes the sample and outcome.

Table 4. Agency Interview Sample

Participating Agencies	Agencies in Sample	Completed Interviews	Cooperation Rate
15	6	6	100%

3.3 Program Materials Review

Opinion Dynamics reviewed the program's procedures manual and the program-tracking database. We reviewed changes made to the manual in October 2017 and October 2018, relative to the program's original 2015 manual. We found the manual sections relating to program operations, customer eligibility guidelines, and measure installation guidelines to be complete and of high quality.

3.4 Participant Survey

Opinion Dynamics implemented a computer-assisted telephone interviewing (CATI) survey in June and July 2020. The survey gathered data to verify participation in the program; develop measure-level estimates of installation, persistence, and in-service rates (ISRs); and support our process evaluation.

The survey sample design and sample size were based on customers who participated during the evaluation period. Of the 1,706 participants in the database, we drew a random sample of 620 valid telephone numbers. We used this sample to complete 102 participant telephone interviews. The average length of the interviews was approximately 15 minutes; the response rate was 18%.

We calculated the response rate using the standards and formulas set forth by the American Association for Public Opinion Research (AAPOR). We chose to use AAPOR Response Rate 3 (RR3), which includes an estimate of eligibility for sample units that we were unable to reach. We present the formulas used to calculate RR3 and the definition of each variable used in the formulas below.

$$RR3 = I / ((I + R + NC + O) + (e * U))$$

$$e = (I + R + NC) / (I + R + NC + E)$$

Table 5. Survey Disposition Category Key

Disposition Code	Disposition Category	Number of Customers
Complete interview	I	102
Eligible incomplete interview	N	7
Survey-ineligible household	X1	1
Not a household	X2	41
Household with undetermined survey eligibility	U1	331
Undetermined if household	U2	138
Estimated proportion of cases of unknown survey eligibility that are eligible	Incidence/e1	99%
Estimated proportion of cases of unknown household eligibility that are eligible	e2	91%

3.5 Consumption Analysis

Opinion Dynamics conducted a consumption analysis to determine the net energy savings attributable to the DEC Weatherization program during the evaluation period. We used separate linear fixed effects regression (LFER) models to estimate the overall net ex post program savings for Tier I and Tier II participants. The fixed effect in our models is the customer, which allows us to control for all household factors that do not vary over time. The consumption analysis used customers who participated from April 2016 through December 2018 as the treatment group and those who participated from January 2019 through March 2020 as the comparison group.

While we conducted consumption analysis for both Tier I and Tier II participants, this evaluation only relies on consumption analysis results for Tier II participants. For Tier I participants, we used a combination of engineering analysis results and impact results from the prior evaluation to assess program savings. We were not able to use Tier I consumption analysis results because they were not statistically significant.¹

Section 4.1.1 provides a summary of the consumption analysis approach; Appendix A contains the detailed methodology description.

3.6 Engineering Analysis

The engineering analysis served several purposes: (1) to develop demand-to-energy savings ratios for Tier I and Tier II projects; (2) to develop ex post energy and demand savings for refrigerator replacements; (3) to understand the relative contribution of different measures to Tier I and Tier II savings; and (4) to develop inputs into Tier I energy savings.

The engineering analysis consisted of two components:

- Measure verification and development of measure-specific ISRs, and
- A deemed savings review of all program measures.

We verified measures and developed measure-specific ISRs based on responses to the participant survey. As part of the deemed savings review, we reviewed measure-level savings and revised input assumptions, as needed, to be consistent with standard industry practice and other Duke Energy Carolinas program assumptions and to align with applicable versions of reviewed TRMs (e.g., Illinois, Indiana, Mid-Atlantic). We also integrated data gathered through the participant survey, for example, the share of participating households with electric domestic water heating.

Appendix B provides more detail on the methods and input assumptions used in the deemed savings review and engineering analysis.

¹ Two factors likely contributed to the inability of the model to detect statistically significant savings: (1) the small number of Tier I participants and (2) the small expected savings of Tier I measures, relative to baseline household electricity usage.

4. Gross Impact Evaluation

4.1 Methodology

The gross impact analysis for the 2016–2018 DEC Weatherization Program included a consumption analysis as well as an engineering analysis. The consumption analysis determined the net evaluated energy (kWh) impacts for Tier II. The engineering analysis supplemented the consumption analysis by:

- Providing a ratio of demand savings (kW) to energy savings (kWh), which is then applied to the consumption analysis net energy savings to calculate net evaluated demand savings;
- Developing ex post energy and demand savings for refrigerator replacements;
- Providing insight into the relative contribution of different measures to Tier I and Tier II savings; and
- Developing inputs into Tier I energy savings.

While we conducted consumption analysis for both Tier I and Tier II participants, this evaluation only relies on consumption analysis results for Tier II participants. For Tier I participants, we used a combination of engineering analysis results and impact results from the prior evaluation to assess program savings. We were not able to use Tier I consumption analysis results because they were not statistically significant.

4.1.1 Consumption Analysis

Opinion Dynamics conducted a consumption analysis to determine the overall evaluated program savings from Tier I and Tier II projects. Consumption analysis is a statistical analysis of energy consumption recorded in utility billing records. Because billing records reflect whole-building energy use, the method is well suited for studying the combined impact of the Weatherization Program's mix of energy-efficiency measures per home. Total program savings from Tier I and Tier II projects are estimated by examining variation among participants' monthly electricity consumption pre- and post-program period, relative to the variation in a comparison group's electricity consumption during those times.

Data Cleaning and Preparation

Prior to specifying the models, we performed thorough cleaning of the consumption and participation data. We checked data for gaps and inconsistencies as well as for sufficiency. Among other checks, we ensured that the participants retained in the analysis had sufficient pre- and post-participation consumption data, participation dates were accurate, and the consumption data was free of outliers, such as bill periods with unreasonably small or unreasonably large consumption.

Comparison Group Selection

Incorporating a comparison group into the consumption analysis allows evaluators to control for changes in economic conditions and other non-program factors that might affect energy use during the study period. Like many other energy efficiency programs, the Weatherization Program was not designed as an experiment. As such, we leveraged a quasi-experimental approach to the evaluation by developing a comparison group of participants. There are multiple approaches to selecting a comparison group, including the use of future participants, past participants, or similar non-participants. When possible, using future program participants as a comparison group is a preferred method. The use of future participants—who are similar to the evaluated

participants—as the comparison group allows to effectively control for self-selection biases. We relied on a comparison group of customers who participated in the Weatherization Program between January 1, 2019 and March 31, 2020.

We performed equivalency checks to assess the similarity of treatment and comparison groups in terms of energy consumption, weather, and housing characteristics in order to validate that the comparison group can serve as a valid baseline. We performed equivalency analysis by tier as well as among Tier II HVAC and weatherization customers separately to ensure balanced consumption among key Tier II subpopulations. Analysis of weather patterns indicates nearly perfect equivalency between the treatment and comparison group customers. Treatment and comparison group participants are also similar across key housing characteristics, such as home vintage, size, and type. As for the consumption data, Tier I treatment participants are a little more likely to have higher heating load than comparison group participants, while Tier II treatment participants are more likely to have a slightly higher cooling load. Both factors are controlled for in the model and are therefore not concerning from a potential bias perspective.

Controlling for Participation in Other Programs

Some customers participated in other Duke Energy programs after participating in the Weatherization Program. Including those customers in the consumption analysis would result in double counting of savings from other programs and artificially inflating the estimate of savings from the Weatherization Program. We dropped those customers from the analysis so that we can get the most accurate estimate of the effects of the Weatherization Program. As part of the analysis, we identified and dropped Weatherization Program participants who cross-participated in the Appliance Recycling Program,² the Residential Energy Efficient Products & Services Program, the Smart Savers Residential Program, and the Residential Energy Assessments Program.³ Overall, we dropped 51% of Tier I and 53% of Tier II participants.

Table 6 below summarizes final participant counts used to develop consumption analysis models.

Table 6. Accounts Included in the Consumption Analysis Model

Program Component	Treatment Group	Comparison Group	Total
Tier I	55	65	120
Tier II	469	469	938
<i>Tier II Weatherization Measures</i>	438	267	705
<i>HVAC Replacement/Upgrade</i>	40	228	268

² The Appliance Recycling Program was discontinued at the end of 2015 but residual participation continued through June 2016.

³ Notably, we only dropped cross-participants who participated in other programs during the 12-month post-period. We retained participants who participated more than a year after participating in the Weatherization Program.

Modeling

We used a Linear Fixed Effects Regression (LFER) model for this analysis. Each tier was analyzed in a separate regression model because the tiers are expected to provide different levels of per-home savings due to differing measures, features, and customer eligibility criteria.⁴

LFER models for each tier included a series of explanatory variables designed to improve our estimate of savings relative to the baseline (i.e., what participants' consumption might have been during the post-program period, had they not received program services). The relationship of interest is between the dependent variable (monthly energy use) and a "dummy" variable that indicates whether an individual participated in the Weatherization Program. Based upon Duke Energy's requests to isolate savings from refrigerator replacements separately from the package of measures provided for each tier, we included an indicator variable to capture the effect of a refrigerator replacement in addition to the tier-related measures, which removes the effect of the refrigerator from the effects of the rest of the measures installed. In addition to excluding savings from the refrigerator measure, Duke Energy was interested in understanding savings from the new HVAC replacement/upgrade measure within the Tier II program component. To accommodate that request, we estimated a Tier II model that included an indicator variable for HVAC replacement/upgrade so that we could separate the impact of this measure from the impact of other Tier II measures.

Consumption analyses typically include a series of additional variables to explain non-program variation in monthly energy use pre- and post-participation. Following best practice, we used a fixed-effects model, which captures the effect of household-specific characteristics that do not vary over time (as customer-specific intercepts).⁵ We also included weather (heating degree days and cooling degree days) in the model. Additionally, we included monthly dummies to further control for seasonal differences in energy consumption overall. After controlling for all of these outside influences, the final model results for the DEC Weatherization Program reflect savings associated with installed measures and any behavioral changes from energy efficiency knowledge gained during their participation process.

Appendix A contains a detailed discussion of the consumption analysis methodology, including data cleaning steps, the equivalency assessment for the comparison group (including cross-participation), and the final model specification and outputs.

4.1.2 Engineering Analysis

As part of the impact evaluation, Opinion Dynamics conducted an engineering analysis for each Weatherization Program measure installed during the evaluation period. The engineering analysis consisted of two distinct steps: (1) measure verification and development of measure specific ISRs; and (2) a deemed savings review of all program measures. Both are described below.

⁴ Note that participants who only received a refrigerator replacement were excluded from the consumption analysis.

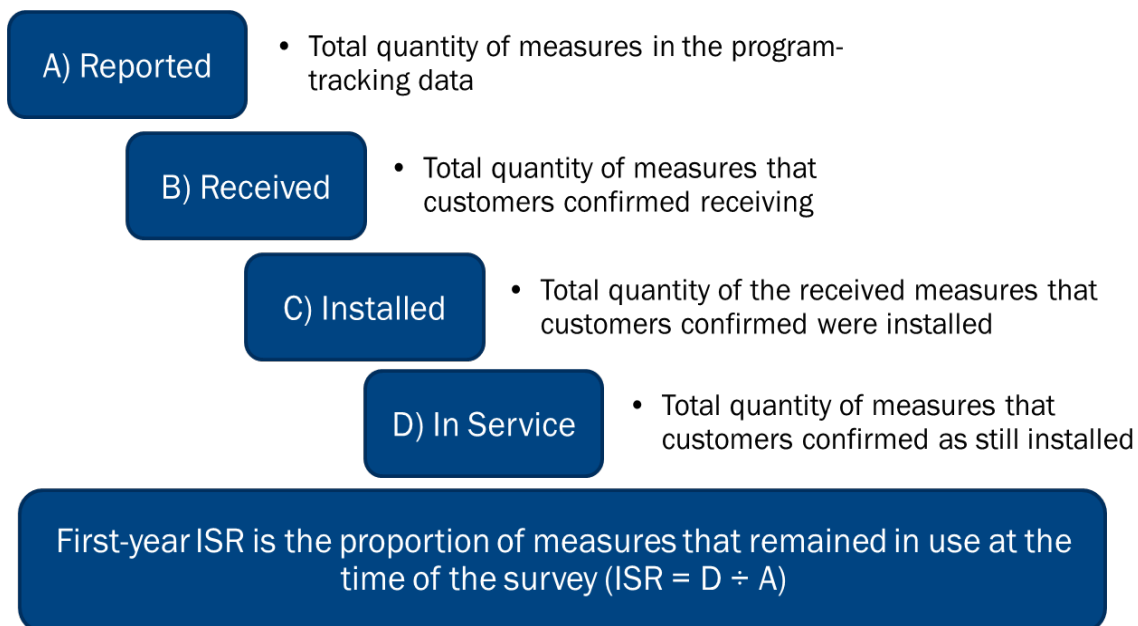
⁵ This includes factors such as building square footage, appliance stock, habitual behaviors and preferences, household size, and others.

Measure Verification

The participant survey included questions designed to verify that participants received and installed program measures and that those measures remained in place and operational. The measure-level ISRs represent the share of measures in the program tracking data that was still in service at the time of the survey, based on 102 completed telephone interviews. Our engineering analysis applied the ISRs to ex post deemed savings to develop total engineering savings.

Figure 2 outlines the method for deriving the ISR for each measure. During the survey, we asked participants to confirm that they received the quantity of measures recorded in Duke Energy's program tracking data and, when necessary, to provide the correct quantity. We also asked participants to confirm the quantity of measures that were installed and remained in service at the time of the survey.

Figure 2. In-Service Rate Components



Based on the survey responses, we calculated the verification, installation, and persistence rates, as well as the resulting ISR—using the equations shown below—for each participant and each measure they received. We then developed averages of all four rates for each measure group.

- 1) $Verification\ Rate = \frac{(B)Received\ Quantity}{(A)Reported\ Quantity}$
- 2) $Installation\ Rate = \frac{(C)Installed\ Quantity}{(B)Received\ Quantity}$
- 3) $Persistence\ Rate = \frac{(D)In\ Service\ Quantity}{(C)Installed\ Quantity}$
- 4) $First\ Year\ InService\ Rate = \frac{(D)In\ Service\ Measures}{(A)Reported\ Measures}$

In previous evaluations of the DEC Weatherization Program and other DEC direct-install programs, Opinion Dynamics found that participants had difficulty verifying certain measures, and that the nature of certain

measures made verification of installation and persistence unnecessary. As such, we made the following assumptions:

- **Water heater tank wrap, pipe wrap, and duct sealing/insulation:** For these measures, we assumed 100% for all four rates as participants are often not aware of the installation of these measures, but once installed, they are unlikely to be removed.
- **Door weather-stripping, refrigerator replacement, heating system upgrade, air sealing, and insulation:** We asked participants to verify receipt of these measures but assumed that agency staff installed 100% of the verified items. We also assume that 100% of installed air sealing and insulation remained installed as they are difficult to remove.

Ex Post Deemed Savings

We used several resources and assumptions to conduct our deemed savings review, including previous DEC low income program evaluations, relevant TRMs (specifically IL, IN, and Mid-Atlantic) and other secondary sources (such as ASHRAE Fundamentals and the US EPA air source heat pump calculator) to examine algorithms and assumptions. Where possible, we used DEC-specific assumptions to estimate measure-specific deemed savings including participant survey data, program-tracking data, and supplemental refrigerator test data. For more information on the algorithms and inputs that our engineering team used to develop deemed savings estimates for each measure, see Appendix B.

Total Program Gross Savings

We developed total program gross savings, by tier, by applying the measure-specific ISRs to the ex post deemed values. We then multiplied the adjusted deemed savings by the measure quantity provided in the program tracking database to arrive at total program savings. Where savings for certain measures rely on electric heating equipment or the presence of cooling equipment, our engineering team developed fuel-specific deemed values and applied them based on the HVAC equipment specified within the program tracking database. Since the database does not provide water heating fuel type, however, we developed weighted savings for water conservation measures based on participant survey responses, which indicated that 78% of participating homes have electric water heating.

We then estimated per household savings for each tier by dividing total tier savings by the number of households participating in that tier.

4.1.3 Tier I Savings

Because the consumption analysis did not generate statistically significant results for Tier I participants, we developed per household Tier I savings using a combination of engineering analysis results and results from the prior evaluation. Specifically, the analysis consisted of the following steps:

- **Step 1:** Develop a ratio of per household Tier I savings based on (1) engineering estimates from this evaluation and (2) normalized engineering estimates from the prior evaluation; and
- **Step 2:** Apply the Tier I savings ratio from Step 1 to Tier I consumption analysis results from the prior evaluation.

The goal of this analysis was to develop a measure of Tier I activity during this evaluation period relative to Tier I activity during the last evaluation period that can then be applied to Tier I consumption analysis results from the prior evaluation.⁶ The following subsections provide more detail on the two steps.

Ratio of Tier I Engineering-based Savings

We developed the Tier I savings ratio using the following equation:

$$\begin{aligned}\text{Tier I Savings Ratio} &= \text{Per HH Tier I Savings}_{2016-18} / \text{Normalized per HH Tier I Savings}_{2015-16} \\ &= 1,014 \text{ kWh} / 1,103 \text{ kWh} \\ &= 0.92\end{aligned}$$

The numerator in this equation (1,014 kWh) is the per household Tier I savings as estimated in the engineering analysis for this evaluation (see Section 4.1.2).

The denominator (1,103 kWh) is estimated by multiplying, for each Tier I measure, the 2015–16 ISR-adjusted quantity by the 2016–18 average Tier I savings value. We “normalized” the 2015–16 Tier I engineering analysis results with deemed savings values from this evaluation to isolate changes in program activity (i.e., changes in the measure mix and the average quantity of measures received by each Tier I participant) between the two evaluation periods. This normalization step was important because updates to deemed savings assumptions resulted in changes to deemed savings values between the two evaluations, in particular for air sealing, the dominant Tier I measure. These changes were made, in part, to develop more consistent assumptions between various Duke program evaluations (as requested by regulatory staff) and are not necessarily reflective of changes in the operation or outcomes of the Weatherization Program.

Final Tier I Savings

We estimated the final per household Tier I savings for the 2016–18 evaluation period as follows:

$$\begin{aligned}\text{Final Per HH 2016–18 Tier I Savings} &= \text{Tier I Savings Ratio} * \text{2015–16 Tier I Savings}_{\text{Consumption Analysis}} \\ &= 0.92 * 262 \text{ kWh} \\ &= 241 \text{ kWh}\end{aligned}$$

The final Tier I per household savings thus leverage the Tier I consumption analysis results from the prior evaluation (262 kWh) but adjust those results by the change in Tier I activity (on a per household basis) between the two evaluation periods (92%).

⁶ We selected this approach since the previous evaluation of this program found that engineering analysis results alone do not provide a good proxy for the consumption analysis. However, engineering analysis results from this evaluation, relative to those from the prior evaluation, provide a good indication of changes in program activity that can be used to adjust the consumption analysis results from the prior evaluation.

4.2 Results

4.2.1 Consumption Analysis

This section provides per-participant consumption analysis results. Appendix A contains the complete results of the models. Table 7 summarizes the results of the consumption analysis models for Tier I and Tier II. The variable “Post” represents the main effect of the treatment, i.e., the change in average daily consumption (ADC) attributable to participation in the DEC Weatherization Program, controlling for whether or not the participant had also received a refrigerator replacement and/or an HVAC replacement/upgrade (applicable to Tier II only). Local weather (expressed as Cooling Degree Days, CDD, and Heating Degree Days, HDD) also significantly impacted consumption.⁷

As can be seen in the table, the participation coefficient for Tier I is not statistically significant, indicating that the model did not establish a statistically significant relationship between participation in the program and energy consumption. For Tier II, all program-related coefficients are statistically significant and negative, indicating a negative relationship between participation and energy consumption, i.e., the presence of savings.

Table 7. Results of Tier I and Tier II Consumption Analysis Models

Variable	Tier 1 Coefficients	Tier 2 Coefficients
Post (Participation Date)	1.071	-5.685***
Refrigerator Replacement Indicator	1.592	-7.262***
HVAC Improvements	–	-4.682**
CDD (Cooling Degree Days)	0.024	0.031***
HDD (Heating Degree Days)	0.008**	0.017***
Constant (Average Intercept)	16.784***	31.924***
Observations (Number of customer bills)	4,816	38,325
Adjusted R-squared	0.527	0.677

* p<0.1, ** p<0.05, *** p<0.01.

Table 8 shows the estimated annual per-home savings for the program. As noted above, the results in the Tier I and Tier II rows reflect the effect of the Weatherization Program alone (any changes in energy use due to other programs are not included) and exclude impacts of the program refrigerator installations. For Tier II, the table isolates estimated savings for Tier II weatherization measures and HVAC replacement/upgrades, respectively.⁸ It should be noted that the estimates of percent savings per home are based on the *modeled*

⁷ The coefficients for the monthly dummies are presented in Appendix A.

⁸ The category “Tier II weatherization measures” includes all Tier II measures other than HVAC Replacement/Upgrade, i.e., it includes measures such as lighting and water heating measures.

baseline usage, including the pre-period usage of both treatment and control group participants, controlling for weather. As such, Table 8 presents a single baseline usage estimate for overall Tier II savings as well as savings for Tier II weatherization measures and the HVAC replacement/upgrade measure.

The savings estimate for Tier I participants is not statistically significant at 90% confidence, indicating that the model could not detect a savings signal. The small sample size relative to the variability in the consumption data as well as the nature and depth of Tier I improvements (smaller expected savings) are likely the key drivers of the model performance. Savings for Tier II participants, on the other hand, are large and statistically significant. Tier II participants saved an average of 2,042 kWh per year, which represents 11.3% of their baseline usage. Savings from Tier II weatherization measures are 2,075 kWh per year, while savings from HVAC replacements/upgrades are 1,709 kWh per year.

Table 8. Annual Per-Participant Energy Savings from Consumption Analysis

Program Component	Modeled Treatment Participants	Per-Participant Baseline Energy Use (kWh/yr)	Ex Post Annual Savings per Participant (kWh)	Average Annual Savings per Participant (% of Baseline Use)	
			kWh Savings	90% Confidence Interval	
Tier I	55	10,198	-391 ^a	-1,107 to 325	-3.8%
Tier II	469	18,087	2,042	1,750 to 2,334	11.3%
<i>Tier II Weatherization Measures</i>	438	18,087	2,075	1,767 to 2,383	11.5%
<i>HVAC Replacement/Upgrade</i>	40	18,087	1,709	472 to 2,945	9.5%

^a Savings for Tier I participants are not statistically significant at 90% confidence.

Compared to the prior evaluation, our Tier II results represent a small, but statistically not significant reduction in annual per household savings. Figure 3 compares the Tier II results from the two evaluations. As can be seen in the figure, the error bounds around the two savings estimates overlap, indicating that the difference between the two estimates is not statistically significant.

Figure 3. Comparison of Tier II Savings to Prior Evaluation



4.2.2 Engineering Analysis

This section provides the results of the engineering analysis, including ISRs and ex post deemed energy and demand savings estimates for each measure offered by the Weatherization Program. In addition, this section summarizes total program and per household savings estimates for the 2016–2018 evaluation period, by project type; provides insight into the contribution of various measures to Tier I and Tier I savings; and presents the Tier I and Tier II demand-to-energy ratios (used to develop Tier I and Tier II demand savings).

Measure Verification Results

Our measure verification analysis showed high ISRs for all measures, as shown in Table 9. DEC Weatherization participants reported that 100% of LEDs, 93% of door weather-stripping, and 85% of efficient showerheads remained in service at the time of the survey. Additionally, while 22% of participants did not recall receiving faucet aerators, 96% of those that did recall having them installed reported that they were still installed at the time of the survey.

Table 9. First Year Measure In-Service Rates

Measure Category	Verification Rate	Installation Rate	Persistence Rate	ISR ^a
LEDs	100%	100%	100%	100%
Faucet Aerators	78%	100%	96%	74%
Showerheads	94%	100%	90%	85%
Door Weather-stripping	99%	Not Asked	91%	93%
Air Sealing	96%	Not Asked	Not Asked	96%
Insulation	98%	Not Asked	Not Asked	98%
Refrigerator	95%	Not Asked	100%	95%
Heating System	100%	Not Asked	100%	100%
Pipe Insulation*				100%
Water Heater Insulation Wrap*				100%
Duct Sealing/Insulation*				100%
CFLs**				84%
Water Heater Temp Adjustment**				100%
Heating System Tune-Up**				90%

^a Note that each rate is developed as the average of respondent-level rates. As such, the ISR may not equal the product of the three other rates.

* Not verified through the participant survey and assumed 100% ISR

** ISR based on 2015 DEC Weatherization participant survey

Ex Post Deemed Savings Results

Table 10 provides the estimated gross per-unit energy and demand savings for all measures installed through the DEC Weatherization Program. As described in Section 4.1.2, we based the measure-level savings on secondary research and applied Weatherization Program-specific assumptions on household characteristics, where applicable.

Table 10. Ex-Post Per-Unit Deemed Savings Estimates

Measure	Tier	Per-Unit Energy Savings (kWh)	Per-Unit Summer peak demand (kW)	Per-Unit Winter peak demand (kW)
Water Heating				
DWH Pipe Insulation (10' sections)	Tier I	142	0.016	0.016
DWH Tank Insulation	Tier I	82	0.009	0.009
Water Heater Temp Adjustment	Tier I	59	0.007	0.007
Low-Flow Showerhead	Tier I	118	0.009	0.017
Low-Flow Aerator	Tier I	74	0.005	0.010
Lighting				
13W CFL	Tier I	16	0.002	0.001
18W CFL	Tier I	35	0.005	0.003
5W Generic LED	Tier I	20	0.003	0.001
5W Specialty LED	Tier I	20	0.003	0.001
9W LED	Tier I	34	0.005	0.002
Air Sealing and Weather Stripping				
Air Sealing (per home)*	Tier I	896	0.310	0.150
Door Weather Stripping (per door)*	Tier I	28	0.010	0.005
Insulation				
Attic Insulation - Cellulose, Blown - R-30*	Tier II	1.0	0.0001	0.0004
Attic Insulation - Cellulose, Blown - R-38*	Tier II	1.1	0.0001	0.0004
Attic Insulation - Fiberglass, Blown - R-30*	Tier II	1.0	0.0001	0.0004
Attic Insulation - Fiberglass, Blown - R-38*	Tier II	1.1	0.0001	0.0004
Belly Fiberglass Loose*	Tier II	0.9	0.0001	0.0003
Floor Insulation - Fiberglass, Batts - R-19*	Tier II	0.9	0.0001	0.0004
Wall Insulation - Fiberglass, Blown - R-13*	Tier II	0.8	0.0001	0.0003
Wall Insulation - Cellulose, Blown - R-13*	Tier II	0.8	0.0001	0.0003
Knee Wall Insulation*	Tier II	0.9	0.0001	0.0004
Manufactured Home Roof Cavity*	Tier II	0.9	0.0001	0.0004
Heating System				
Heating System Tune-up (per system)	Tier I	488	0.023	0.088
Duct Insulation (per system)*	Tier II	261	0.042	0.095
Duct Sealing (per system)*	Tier II	1,316	0.210	0.479
HVAC Upgrade/Replacement				
Heat Pump Upgrade (per heat pump)	Tier II	834	0.096	0.313
Heat Pump Replacement (per heat pump)	Tier II	1,438	0.168	0.541
Refrigerator				
ENERGY STAR® Refrigerator (15 cu. ft.)	Tier I	936	0.107	0.107
ENERGY STAR® Refrigerator (18 cu. ft.)	Tier I	692	0.079	0.079
ENERGY STAR® Refrigerator (21 cu. ft.)	Tier I	835	0.095	0.095

* Weighted based on mix of 2016–18 participants with different heating fuel and cooling equipment.

Total Program and Per-Household Savings

We calculated total program savings for the evaluation period by applying the ISRs shown in Table 9 to the per-unit estimates shown in Table 10. We then multiplied these ISR-adjusted per-unit estimates by the respective measure quantities in the program tracking database.

Table 11 summarizes total gross program energy and demand savings, by measure, for the 2016–2018 evaluation period. It also shows average measure quantity per participating household.

Table 11. Engineering Analysis Total Gross Savings by Measure

Measure	Unit	Energy Savings (kWh)	Summer Peak Demand (kW)	Winter Peak Demand (kW)	Average Qty per Household
Water Heating					
DWH Pipe Insulation	Water heaters	92,443	10.55	10.55	0.4
DWH Tank Insulation	Water heaters	45,237	5.16	5.16	0.3
Water Heater Temp Adjustment	Water heaters	3,557	0.41	0.41	< 0.1
Low-Flow Showerhead	Showerheads	54,085	3.93	7.85	0.3
Low-Flow Aerator	Aerators	46,290	3.15	6.30	0.5
Lighting					
13W CFL	Lamps	21,352	3.16	1.53	0.8
18W CFL	Lamps	23,842	3.53	1.71	0.4
5W Generic LED	Lamps	669	0.10	0.05	< 0.1
5W Specialty LED	Lamps	669	0.10	0.05	< 0.1
9W LED	Lamps	24,529	3.63	1.76	0.4
Air Sealing and Weather Stripping					
Air Sealing	Households	1,160,999	378.85	218.77	0.72
Door Weather Stripping	Households	44,890	14.46	8.66	0.88
Insulation					
Attic Insulation - Cellulose, Blown - R-30	Sq. Feet	49,514	6.88	19.07	28
Attic Insulation - Cellulose, Blown - R-38	Sq. Feet	85,168	11.83	32.80	46
Attic Insulation - Fiberglass, Blown - R-30	Sq. Feet	357,907	49.71	137.84	202
Attic Insulation - Fiberglass, Blown - R-38	Sq. Feet	377,195	52.39	145.27	204
Belly Fiberglass Loose	Sq. Feet	172,431	23.95	66.41	110
Floor Insulation - Fiberglass, Batts - R-19	Sq. Feet	359,150	49.88	138.32	229
Wall Insulation - Fiberglass, Blown - R-13	Sq. Feet	19,646	2.73	7.57	10
Wall Insulation - Cellulose, Blown - R-13	Sq. Feet	13,602	1.89	5.24	15
Knee Wall Insulation	Sq. Feet	7,657	1.06	2.95	5
Manufactured Home Roof Cavity	Sq. Feet	79,721	11.07	30.70	51
Heating System					
Heating System Tune-up	Households	161,797	6.03	30.28	0.2
Duct Insulation	Households	3,682	0.50	1.43	< 0.1
Duct Sealing	Households	1,265,635	176.00	487.21	0.5

Measure	Unit	Energy Savings (kWh)	Summer Peak Demand (kW)	Winter Peak Demand (kW)	Average Qty per Household
HVAC Upgrade/Replacement					
Heat Pump Upgrade	Households	158,449	18.30	59.54	0.1
Heat Pump Replacement	Households	185,559	21.66	69.73	0.1
Refrigerator					
ENERGY STAR Refrigerator (15 cu. ft.)	Refrigerators	68,827	7.85	7.85	< 0.1
ENERGY STAR Refrigerator (18 cu. ft.)	Refrigerators	112,883	12.88	12.88	0.1
ENERGY STAR Refrigerator (21 cu. ft.)	Refrigerators	124,387	14.19	14.19	0.1

Table 12 summarizes total and per household gross program energy and demand savings, by project type.

Table 12. Engineering Analysis Gross Program Savings

Project Type	Unique Participating Households	Energy Savings (kWh)	Summer Peak Demand (kW)	Winter Peak Demand (kW)
Total Program Savings				
Tier I	176	178,487	53.6	30.8
Tier II	1,387	4,662,487	809.0	1,469.8
<i>Tier II Weatherization Measures</i>	1,146	4,318,480	769.1	1,340.6
<i>HVAC Replacement/Upgrade</i>	318	344,008	40.0	129.3
Refrigerator Replacement	404	306,097	34.9	34.9
Total	1,706	5,147,071	897.6	1,535.6
Average Savings per Household				
Tier I	176	1,014	0.305	0.175
Tier II	1,387	3,362	0.583	1.060
<i>Tier II Weatherization Measures</i>	1,146	3,768	0.671	1.170
<i>HVAC Replacement/Upgrade</i>	318	1,082	0.126	0.406
Refrigerator Replacement	404	758	0.086	0.086

Measure Mix and Contribution to Tier I and Tier II Savings

Based on program-tracking data, almost all Tier I and Tier II participants (96% and 97%, respectively) received air sealing. The vast majority (91%) of Tier II participants also received insulation, and 74% received duct system sealing or insulation—measures not offered to Tier I participants. Larger shares of Tier II participants than Tier I participants received water heating measures, weather-stripping, lighting, and heating system tune-ups. Overall, 24% of participants received a new refrigerator and 19% an HVAC replacement or upgrade. Notably, 8% of participants only received a new refrigerator and 14% only received an HVAC replacement/upgrade.

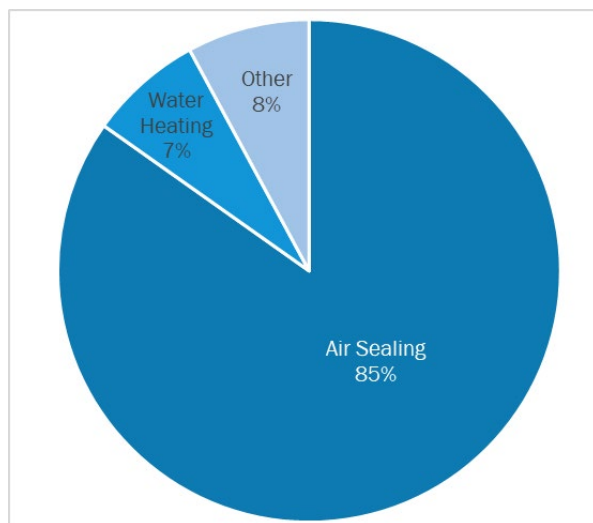
Table 13. Measure Mix

Measure Category	% of Participating Households Receiving Measure Category ^a		
	All Participants (N=1,706)	Tier I Participants (N=176)	Tier II Participants (N=1,146)
Air Sealing	75%	96%	97%
Insulation	61%	n/a	91%
Duct System	50%	n/a	74%
Water Heating	50%	31%	70%
Weather-stripping	43%	35%	59%
Lighting	26%	26%	35%
Heating System Tune-Up	19%	6%	27%
Refrigerator Replacement	24%	19%	17%
HVAC Replacement/Upgrade	19%	1%	7%

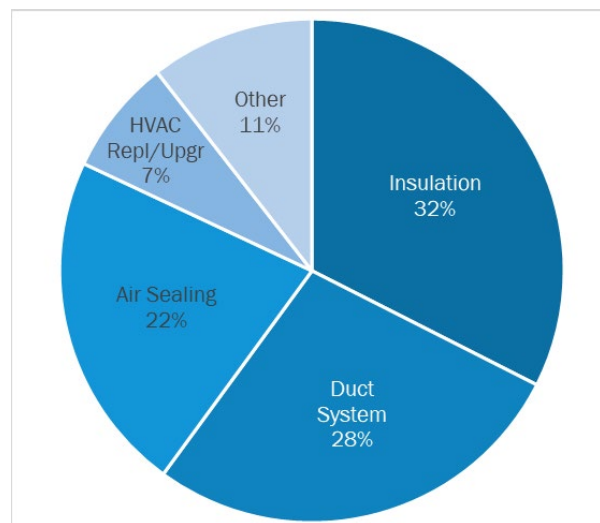
^a Values are based on program-tracking data and do not incorporate ISRs.

Based on ex post gross engineering analysis results, Tier I savings during the evaluation period came primarily from air sealing (85%). Another 7% came from water heating measures and 8% came from other Tier I measures (including heating system tune-ups, 3%; lighting measures, 3%; and weather-stripping, 2%). Tier II savings, on the other hand, were dominated by insulation (32%), duct system sealing and insulation (28%), and air sealing (22%). HVAC replacements/upgrades accounted for 7% of engineering-based Tier II savings during the evaluation period, while other Tier II measures (including water heating measures, 5%; heating system tune-ups, 3%; and lighting and weather-stripping, 1% each) contributed 11% (see Figure 4).

Figure 4. Measure Contribution to Total Tier I and Tier II Energy Savings



Tier I kWh Savings



Tier II kWh Savings

Demand-to-Energy Ratios

Using the estimated savings from Table 12, we calculated overall kW-per-kWh savings ratios, by Tier (see Table 14). We used these ratios to estimate per household net demand savings for Tier I and Tier II.

Table 14. Engineering Demand-to-Energy Ratios

Project Type	Total Gross Energy Savings (kWh)	Summer Coincident Peak Savings (kW)	Winter Coincident Peak Savings (kW)	Summer Ratio Multiplier (summer demand/energy savings)	Winter Ratio Multiplier (winter demand/energy savings)
Tier I	178,487	53.62	30.80	0.0003004	0.0001726
Tier II	4,662,487	809.04	1,469.84	0.0001735	0.0003152

4.2.3 Tier I Savings

A comparison of installed units (inclusive of evaluation-specific ISRs) between the two evaluation periods shows that participants during the 2016–2018 evaluation period were more likely to complete air sealing and received more weather stripping than participants during the 2015–16 evaluation period but installed fewer efficient lamps (CFLs or LEDs). In addition, the average Tier I home during the 2016–18 evaluation period was less likely to receive a heating system tune-up or implement any of the five water heating measures offered by the program.

Applying 2016–2018 per unit savings for Tier I participants to installed units results in annual per household Tier I savings of 1,014 kWh during the current evaluation period, compared with 1,103 kWh for the prior evaluation period. The resulting Tier I Savings Ratio is 0.92 (1,014 kWh / 1,103 kWh), meaning that based on the measure mix and installed measure quantities, per household Tier I savings for the 2016–18 evaluation period could be expected to be 92% of Tier I savings for the 2015-16 evaluation period.

Table 15 summarizes the comparison between Tier I participants in the two evaluation periods.

Table 15. Tier I Savings Comparison with Participants from Prior Evaluation

Measure	Savings Unit	Installed Units / Participant ^a		2016-18 per Unit kWh Savings ^b	Per Participant kWh Savings	
		2015-16	2016-18		2015-16	2016-18
Air Sealing and Weather Stripping						
Air Sealing	Home	0.90	0.92	926.6	831	852
Door Weather Stripping	Door	0.56	0.62	30.2	17	19
Lighting						
CFL 13W	Lamp	2.20	0.41	16.2	36	7
CFL 18W	Lamp	0.64	0.29	35.5	23	10
LED 5W Generic	Lamp	-	0.03	20.3	-	1
LED 5W Specialty	Lamp	-	0.08	20.3	-	2
LED 9W	Lamp	-	0.36	34.5	-	12
Heating System						
Heating System Tune Up	System	0.11	0.05	603.9	65	31

Measure	Savings Unit	Installed Units / Participant ^a		2016-18 per Unit kWh Savings ^b	Per Participant kWh Savings	
		2015-16	2016-18		2015-16	2016-18
Water Heating						
DWH Pipe Insulation	10' Section	0.28	0.19	141.8	40	27
DWH Tank Insulation	System	0.26	0.21	82.1	21	17
Water Heater Temp Adjustment	System	0.10	0.02	59.3	6	1
Low Flow Showerheads	Showerhead	0.23	0.14	118.1	27	17
Low Flow Aerators	Aerator	0.50	0.24	74.4	37	18
Total Tier I Savings					1,103	1,014

^a Inclusive of evaluation-specific ISRs

^b Savings represent averages for Tier I participants only and are exclusive of ISRs.

Applying the Tier I Savings Ratio of 0.92 to the Tier I consumption analysis result from the prior evaluation (262 kWh per household) results in estimated per household Tier I savings of 241 kWh for the 2016–18 evaluation period:

$$\text{Final Per Household Tier I Savings} = 0.92 * 262 \text{ kWh} = 241 \text{ kWh}$$

4.3 References

The following sources were used in the engineering analysis:

- ASHRAE Fundamentals. Appendix: Design Conditions for Selected Locations. Chapter 14
- ENERGY STAR® Air Source Heat Pump Calculator
- Illinois Technical Reference Manual. Version 6.0. February 11, 2016
- Indiana Technical Reference Manual. Version 2.2. July 28, 2015
- Michigan Evaluation Working Group Showerhead and Faucet Aerator Meter Study Memorandum. June 2013
- Mid-Atlantic Technical Reference Manual. Version 9.0. October 2019
- Baseline refrigerator energy consumption based on test measurement data provided by Duke Energy for 142 refrigerators
- 2016–2018 DEC LI Weatherization program tracking database
- 2016–2018 DEC LI Weatherization participant survey conducted by Opinion Dynamics in 2020
- Opinion Dynamics Corporation. Duke Energy Carolinas – 2015 Low Income Weatherization Program Evaluation Report. June 13, 2018.

5. Process Evaluation—Weatherization Program

5.1 Researchable Questions

Based on discussions with Duke Energy program and evaluation, measurement, and verification (EM&V) staff, the evaluation team developed the following process-related research questions:

- Have there been any major process changes since the last evaluation, and what effects have they had on CAA participation levels, measure mix, and per-household savings?
- What are the major strengths of the program? Are there specific ways that the program could be improved to be more effective in the future?
- Are participating agencies satisfied with the program? What are their barriers to program participation (i.e., are there limiting factors to achieving greater participation)?
- What policy barriers to agency participation still exist in the South Carolina portion of DEC's service area? What, if any, program process improvements can DEC make to enhance its impact in that state?
- Are participants satisfied with the program and measures received? What types of non-energy benefits have they received since participating?

5.2 Methodology

Our process evaluation relied on (1) interviews with program staff, the program coordinators (NCCAA and TRC), and six participating agencies; (2) review of program materials and program-tracking data; and (3) analysis of the participant survey.

The full survey instrument can be found in Appendix C.

5.3 Key Findings

5.3.1 Program Participation

The 2016–2018 program comprised the second, third, and fourth years of the DEC Weatherization Program. Between April 1, 2016 and December 31, 2018, 15 participating agencies in North Carolina served 1,706 households. The majority of participating households (81%) completed a Tier II project; 10% completed a Tier I project; and 24% received a new refrigerator (either in combination with a Tier I or Tier II project, or as a stand-alone measure).

Of the 15 participating agencies, eleven were already active during the prior evaluation period and four were new to the program. The 15 agencies submitted between 1 and 746 weatherization projects, with an average of 136 (Table 16).

Table 16. 2016-2018 CAA Projects by Tier

Agency	Tier I	Tier II	Refrigerator Replacement	Total
Blue Ridge Community Action Inc.	102	497	147	746
Blue Ridge Opportunity Commission	9	39	3	51
Cabarrus County Planning & Development Services	7	27	9	43
Central Piedmont Community Action Inc.*	0	2	0	2
Charlotte Area Fund Inc.*	0	0	18	18
Community Action Opportunities	12	159	25	196
Four Square Community Action Inc.	5	17	24	46
I CARE Inc.	1	13	1	15
Macon County Government	3	40	0	43
Mountain Projects Inc.	1	28	4	33
Piedmont Triad Regional Council	4	451	118	573
Rebuilding Together of the Triangle*	0	1	0	1
Resources for Seniors	14	39	16	69
Salisbury-Rowan Community Action Inc.*	1	8	1	10
Yadkin Valley Economic Development District Inc.	17	145	38	200

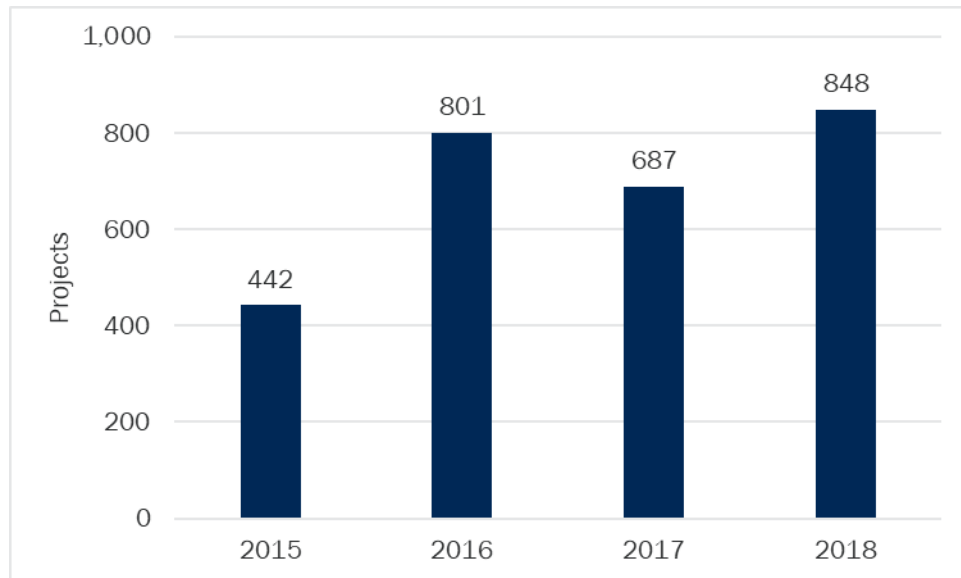
*Denotes agencies new to the DEC Weatherization program in the 2016–2018 evaluation period, based on a review of participating agencies in the 2015–2016 evaluation period.

During the evaluation period, the program provided incentives for over 2,000 projects at 1,706 homes, all in North Carolina.⁹ On an annual basis, 2018 represented the largest number of projects (848) since program initiation in 2015 while 2017 saw a dip in project completion (687) compared to 2016 (801).

Figure 5 shows the total number of projects completed each year, from 2015 through 2018. It should be noted that 2016 includes 290 projects from the prior evaluation period (which included January through March 2016).

⁹ Projects are defined by project numbers found in the tracking database, which denotes HVAC and refrigerator replacements as separate projects when a participant also receives Tier I or Tier II measures.

Figure 5. DEC Weatherization Projects Per Year 2015-2018

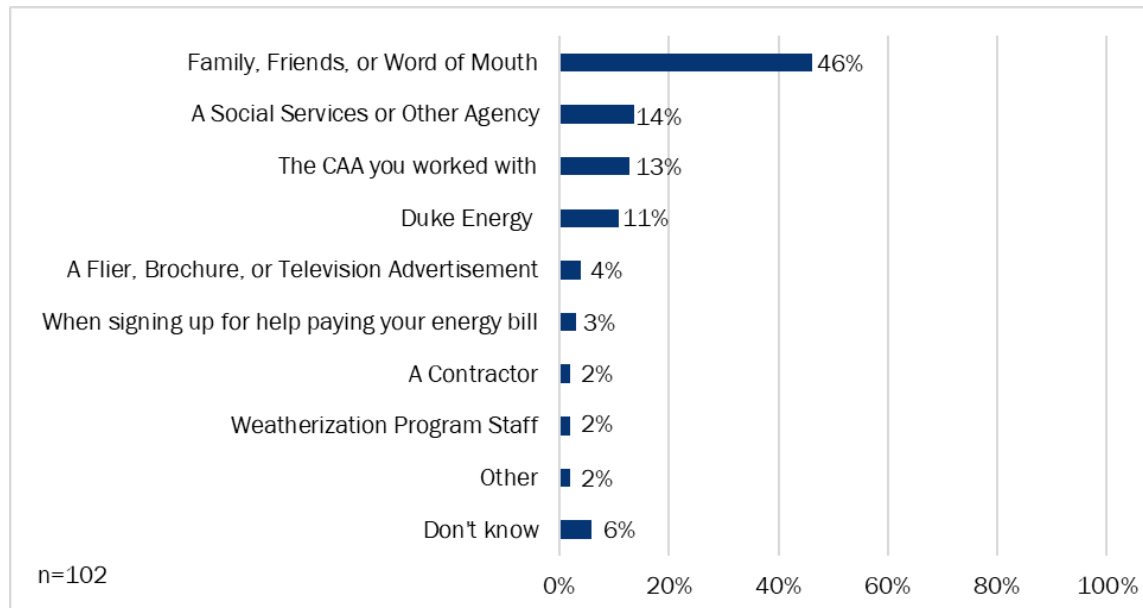


5.3.2 Program Outreach and Motivators of Participation

Agencies complete their own marketing and outreach to generate a local pipeline of State and DOE weatherization projects; Duke Energy does not conduct any additional marketing. Interviewed agencies (n=6) most often reported marketing the program through newspaper ads, fliers, in-person marketing (events and door-to-door canvassing), partnerships with other organizations, and their own websites (4/6). Only half of interviewed agencies market the program on social media and even fewer use mail (2/6) or television ads (1/6).

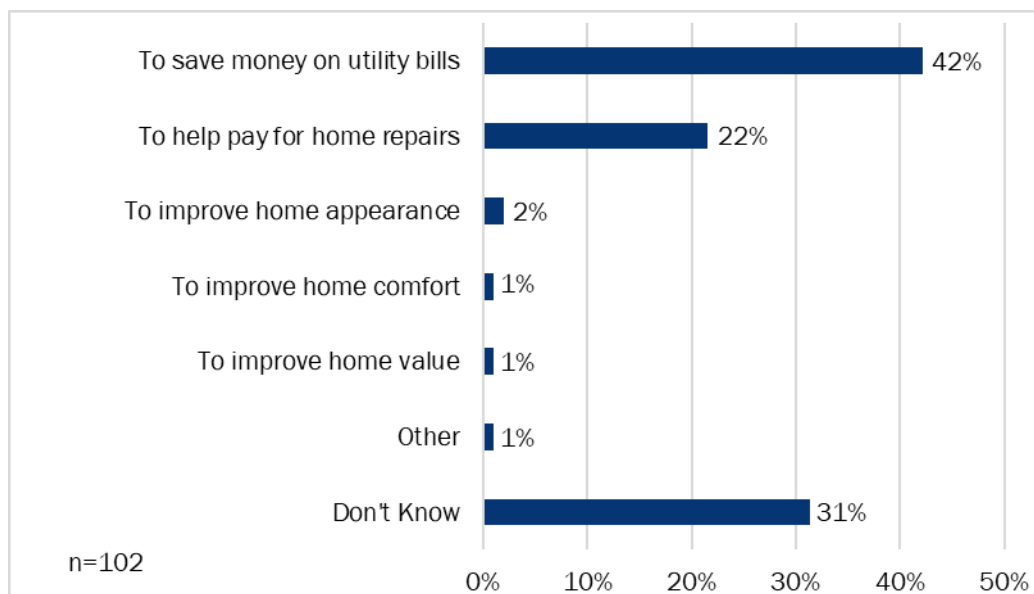
According to responses to the participant survey, nearly half (47%) of participants learned about the Weatherization Program through word of mouth; smaller shares of participants learned about the program through social services or another agency (14%), their CAA (13%), or directly from Duke Energy (11%) (see Figure 6).

Figure 6. How Participants First Heard About the DEC Weatherization Program (Multiple Response)



The main driver of customer participation is to save money on utility bills (42%) or to help pay for home repairs (22%) (see Figure 7). Interestingly, making the home more comfortable is not a main motivator for participation, even though it is a main non-energy benefit identified by participants (see Section 5.3.4).

Figure 7. Participants' Main Motivation in Signing Up for Weatherization



5.3.3 Participating Agencies' Program Experience

In general, agency staff expressed great appreciation for the DEC Weatherization Program and emphasized the high level of need for weatherization services among their clients. DEC Weatherization projects represent a large portion of weatherization jobs completed by the agencies and half of interviewed agencies utilized the new participation channel in which they can submit projects for reimbursement that were not originally DOE or State WAP projects. Most interviewed agencies provide additional services for their clients outside of weatherization, but all reported their clients have difficulty paying high energy bills. Agencies did not significantly change how they implement or participate in the program since the last evaluation, and policy barriers in South Carolina continued to prevent program participation in the state.

Agency Participation Summary

All but one agency we interviewed (5/6) had been involved with the DEC Weatherization Program prior to the current evaluation period; the only new agency we interviewed reported first participating in the DEC Weatherization Program in May 2016. Most interviewed agencies (5/6) reported they complete weatherization projects through DOE/State WAP while half (3/6) also complete projects through LIHEAP. One agency reported they only complete refrigerator replacement projects for the DEC Weatherization Program, although they provide other services to their clients outside of the Weatherization Program. Three agencies indicated they had utilized the new participation channel, in which they completed and submitted projects that were not originally DOE or State WAP projects. Overall, agencies submit an average of 81% of their total weatherization projects to DEC for reimbursement. All interviewed agencies reported that they submit 100% of eligible projects for DEC Weatherization Program reimbursement. Table 17 presents an overview of agency activity and program participation during the evaluation period.

Table 17. Agency Activity and Participation

Agency Metrics	Average	Range
Number of DEC projects (n=6)	306	18 to 746
Share of DEC projects relative to all weatherization jobs (n=5)	81%	64% to 91%
Percent of all weatherization jobs that were originally DOE funded (n=5)	21%	15% to 40%
Percent of all weatherization jobs that were originally LIHEAP funded (n=3)	66%	60% to 70%
Percent of eligible projects submitted for DEC Weatherization Program reimbursement (n=5)	100%	100% to 100%

Key Services and Customer Concerns

Most interviewed agencies (4/6) perform a wide variety of services in their communities beyond weatherization; only two interviewed agencies reported they exclusively provide weatherization services and health and safety upgrades to their clients' homes. Half of agencies (3/6) also have senior assistance and/or nutrition programs, and many agencies perform other necessary work in their communities through workforce development programs (2/6), childcare and education programs (1/6), and environmental compliance programs (1/6).

All six interviewed agencies reported that the biggest housing/energy concern their clients face are extremely high energy bills, which can be a struggle to pay on a low or fixed income. Half of interviewed agencies (3/6) also noted their clients' homes were in need of repairs or upgrades, such as gaps in doors or missing insulation. Two agencies reported their clients have trouble maintaining adequate indoor temperatures. One interviewee reported their clients sometimes resort to dangerous ways of warming their homes, saying "when

your heat breaks you wind up ... getting gallon jugs and putting kerosene in them and getting a kerosene heater and bringing it into your house. Then it smokes your house up but you're warm and it's dangerous."

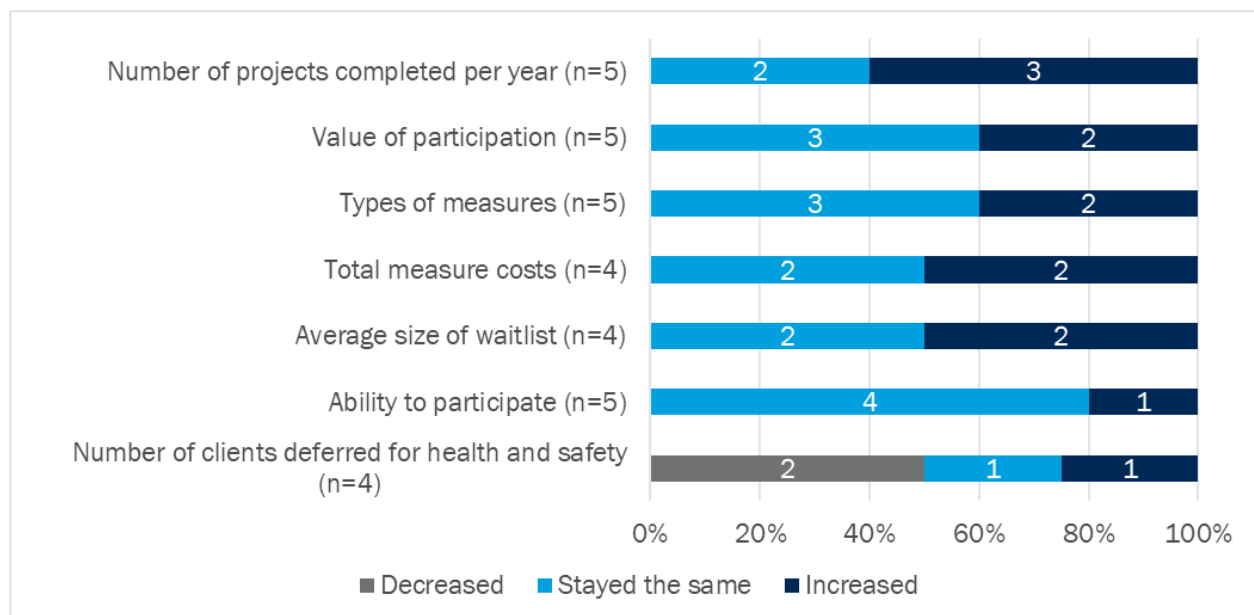
Program Changes

In 2018, the DEC Weatherization Program introduced a new participation channel in which agencies could submit for reimbursement qualifying weatherization projects funded from their operating budget or another source. Prior to this change, agencies could only submit qualifying DOE/State WAP projects for DEC Weatherization reimbursement. This change allowed agencies other than CAAs, such as non-profit organizations, to be able to deliver program services to their clients in North and South Carolina. DEC made this change in an effort to bypass the strict DOE rules for how agencies spend weatherization funds and to increase program participation in South Carolina. Three out of six agencies indicated they used this new participation channel, utilizing grants, operating budgets, and credit at local home improvement stores to fund the projects before they received reimbursement from DEC.

Interviewed agencies that also participated in the program during the prior evaluation period (2015 to Q1 2016, n=5) noted only minimal changes in how they delivered or participated in the DEC Weatherization Program during the evaluation period. Two of these five agencies reported they did not change anything about how they delivered or participated in the program since the last evaluation. One agency noted they were able to hire additional staff and serve more clients on their deferral list, and another agency noted they started submitting for HVAC replacement projects during this evaluation period. One agency reported they decreased spending on health and safety due to the loss of a \$3,000 per house payment for health and safety measures from DEC. The agency noted this occurred in 2017 or 2018, when the funds for the Helping Home Fund (HHF) ran out.

To further understand specific changes to program implementation, we asked agency staff to identify changes that may have occurred in a variety of program areas over the past four years. The most frequently reported change was an increase in the number of projects completed per year (3/5). Figure 8 summarizes agency responses.

Figure 8. Changes to Agency Participation



Agency staff noted that changes to the types of measures installed include HVAC replacements (1/6) and the new measures DEC added to the program during this evaluation period, including roof cool seal (1/6). One agency noted their ability to participate increased over the last four years since they were able to complete weatherization jobs at more homes.

We also asked the returning agencies if there have been any changes over the last four years in how they coordinate the implementation of multiple weatherization programs. Half of agencies reported no changes (2/4). One agency reported their coordination efforts tend to change within their funding cycle, rather than from year to year, but have not changed substantially over the last four years. Another agency reported they increased outreach efforts to other community agencies and nonprofits, and ensure their partnering agencies are aware of Weatherization Program requirements so they can get referrals.

Policy Barriers

Our last evaluation identified significant policy barriers to agency participation in the DEC Weatherization Program in both states but specifically in South Carolina. During the current (2016–2018) evaluation period, many interviewed agencies in North Carolina reported being able to complete more projects per year and reduce the number of people they defer for health or safety reasons; however, policy barriers remain in South Carolina, and not one South Carolina agency participated during the evaluation period.

In 2015, DOE's policies in North Carolina required that agencies spend DEC funding within the same program year. This limited agencies' willingness to participate in the first year of the program because they were not certain that they could spend both the DEC and State WAP funding. This hesitancy led North Carolina agencies to request less than the full value of available funds. Since then, DOE revised its policy, allowing North Carolina agencies to use DEC Weatherization funds as 'unrestricted' income beginning in 2016. As noted above, participating agencies are now requesting funding for 100% of their eligible projects. The North Carolina agencies' annual number of DEC program-eligible State WAP projects provided an upper bound to the amount of funding Duke Energy reasonably expected to distribute each year until the recent addition of the new participation channel. This new participation channel allows participating agencies to submit completed DEC Weatherization projects for reimbursement, regardless of the original funding source. Three of the six interviewed agencies indicated they used this new participation channel, and used funds from other programs, grants, or their operating budgets to pay for the project before receiving reimbursement from Duke Energy.

In South Carolina, agencies continue to struggle to participate in the DEC Weatherization Program. According to NCCAA, South Carolina has a relatively high need for weatherization services and could benefit greatly from DEC Weatherization funding. DOE considers DEC Weatherization Program reimbursements in South Carolina "program income," and agencies must return any unspent program income to DOE at the end of the WAP fiscal year. This could result in DOE reducing funding allocations to the South Carolina agencies in future program years. To prevent this, the State WAP does not allow South Carolina agencies to participate in the DEC Weatherization Program. In addition, NCCAA reported that CAAs in South Carolina are entirely state funded, and CAA employees are considered "state-paid employees." While CAAs receive enough funding from the state to cover their payroll, they often do not have funds left over to pay for weatherization projects, and CAA employees are barred from working on projects using privately funded grants, including DEC Weatherization projects. One of the goals of the new participation channel was to overcome these barriers by allowing non-profits or other non-CAA organizations to provide program services. The program has so far remained unsuccessful in expanding program services into South Carolina, however, despite this new participation channel. NCCAA and TRC believe that the program will continue to struggle in South Carolina as long as these state policies remain in place.

Growing the Program

During the previous evaluation, 12 agencies participated in the DEC Weatherization Program. Since then, one agency left and four new agencies joined the program, bringing the total number of participating agencies in the 2016–2018 evaluation period to 15. Program administration staff reported that they do not perform agency recruitment for the program, and new agencies typically start participating in the program due to reassigned service territories. Program administration staff indicated that some new agencies tend to complete HVAC or refrigerator replacement projects due to the “safer” nature of those projects (in terms of agencies knowing the reimbursement amount upfront), and oftentimes homes are in need of HVAC replacements (if they do not have working heat) before they can receive weatherization services through the State WAP. Program administration staff also noted that participating agencies can be non-profit agencies that do not specialize in weatherization or home upgrades due to the new flexible participation channel. This option is particularly attractive for South Carolina as restrictions surrounding State WAP and the use of private funds continue to be a policy barrier for weatherization agencies in the state.

A minor barrier to agency interest found in the last evaluation was a limited capacity to spending program funding once agencies received it due to funding restrictions surrounding State WAP projects, particularly in South Carolina. Although no new projects were completed in South Carolina during the evaluation period, many agencies in North Carolina were able to spend their DEC Weatherization reimbursements, and three of six interviewed agencies indicated they could weatherize more homes or otherwise increase their participation in the program if the program offered more money.

5.3.4 Non-Energy Impacts

NEIs include a range of occupant health, safety, and economic outcomes that participants may realize beyond the energy and cost savings of energy-efficient upgrades. NEIs can provide significant additional benefits to participants and can be a powerful motivator for program participation.

The participant survey included questions about changes in electricity bills and in different aspects of the home’s comfort following program participation. Most Weatherization Program participants reported that their summer and winter electricity bills were lower compared to before they participated in the program and that they experienced other beneficial changes. Beneficial NEIs reported by two-thirds or more of participants include increased home comfort in both summer and winter, reduced draftiness, and better lighting. Fewer than half of respondents reported a reduction in outdoor noise and home maintenance costs (Table 18). In addition, a small share of respondents (less than 20%) reported other beneficial changes as a result of their participation, including improved quality of life, improved water efficiency in their homes, and improved home safety.

Table 18. Impacts Reported by Participants

Impact Category	Positive Change	No Change/ About the Same	Negative Change
Energy Impacts			
Summer electricity bills (n=99) ^a	73% <i>Bills are lower</i>	24%	3% <i>Bills are higher</i>
Winter electricity bills (n=99) ^a	58% <i>Bills are lower</i>	32%	10% <i>Bills are higher</i>
Non-Energy Impacts			
Home comfort in the summer (n=102)	76% <i>More comfortable</i>	22%	2% <i>Less comfortable</i>
Home comfort in the winter (n=101)	70% <i>More comfortable</i>	26%	4% <i>Less comfortable</i>
Home draftiness (n=100)	68% <i>Less drafty</i>	26%	6% <i>More drafty</i>
Lighting (n=9) ^b	67% <i>Better</i>	33%	0% <i>Worse</i>
Amount of outdoor noise heard when all windows are closed (n=98)	46% <i>Less noise</i>	49%	5% <i>More noise</i>
Home maintenance costs (n=96)	33% <i>Lower costs</i>	53%	14% <i>Higher costs</i>

^aAsked only of those who pay their own electric bill.

^bAsked only of those who received LEDs.

These findings suggest the Weatherization Program provides value to participants beyond energy savings. Increased home comfort and reduced draftiness could be beneficial for customer health and safety, especially as climate change alters temperature patterns. Improved lighting provides a higher sense of safety in and around the home. Lower energy bills and home maintenance costs help alleviate energy burdens and allow customers to spend their money on essential items, such as food and medicine.

DEC should consider providing information regarding improved home comfort, draftiness, and lighting quality to agencies to help them market the program. Duke could also use this information to recruit new agencies to the program whose clients face high energy bills or uncomfortable homes in the winter and summer.

5.3.5 Program Satisfaction and Strengths

Overall, program administration staff, implementing agency staff, and participants are all highly satisfied with the DEC Weatherization Program:

- NCCAA and TRC program administration staff gave the program a satisfaction score of six out of six, saying they were very satisfied and “we’d love to do more but we’ve got what we’ve got, and it’s made a big difference.” Program administration staff are particularly pleased with the new flexible participation channel for agencies, who are no longer required to complete DOE or LIHEAP projects to be reimbursed by DEC. This allows for other nonprofits, not just CAAs, to participate in the program, which could help reduce the policy barriers to participation in South Carolina. Program administration staff are also extremely pleased with their interactions with Duke Energy and reported that Duke Energy has been a great partner to them and the CAAs. They also reported the program has likely reduced the size of agency waitlists and agencies have been able to serve more people than they

would have otherwise. In addition, program administration staff noted HVAC and refrigerator replacement projects as program strengths, which allow other agencies or non-profits to participate in the program, as well as the recent increase in the incentive for refrigerator replacements. Program administration staff noted they would like to increase participation, but they are satisfied with the work they do, and it makes a big difference in the lives of clients.

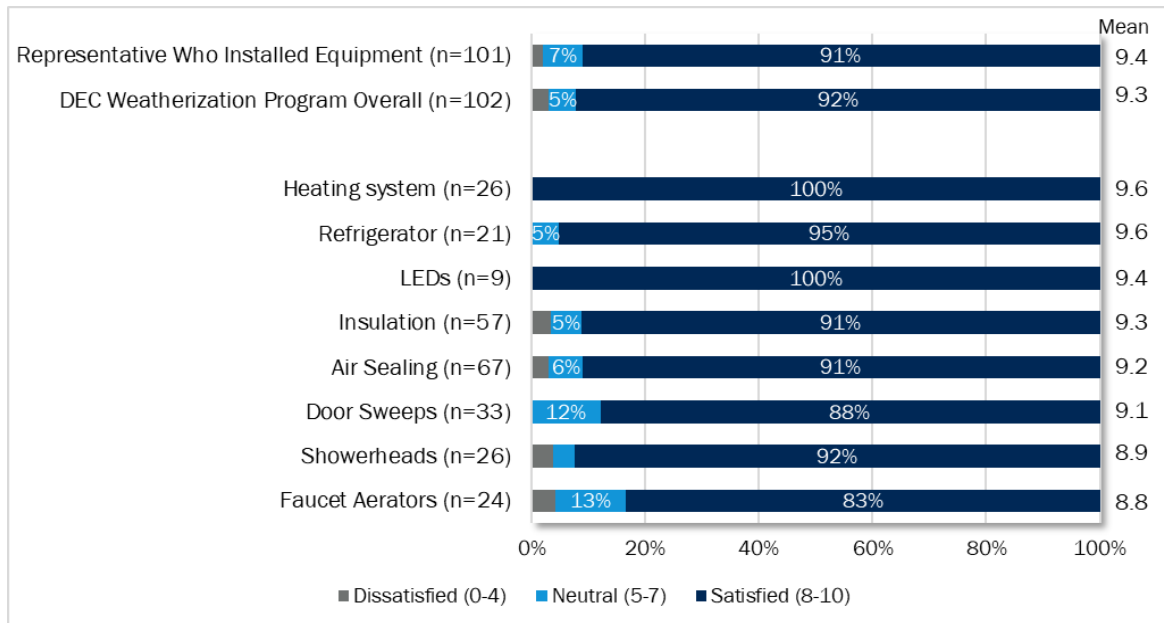
- **Agency staff are very satisfied with the program as well, giving it an average rating of 5.9 out of 6 (n=6).** Agency staff reported few issues with implementation and underscored the value of the program to their communities. Agencies are particularly satisfied with logistical elements of the program, and most interviewed agency staff members noted program organization, communication, and the ease of participation and reporting requirements as key program strengths (5/6). One staff member mentioned the flexibility of reimbursements was a key program strength and another highlighted the program's role in their agency serving more clients. Agency staff frequently provided unprompted praise for program administrative staff during our interviews, one saying "... the folks that were back and just willing to help you any way they could to implement and get this program going. The resources were phenomenal, the teamwork. I've never seen anything like it. It was just great."

As noted above, only one of the interviewed agencies indicated they began participating in the program during the evaluation period. This agency reported no issues with blending Duke funds with other sources of funding, obtaining DEC reimbursements, or meeting participation or documentation requirements. This agency also participates in the State WAP and the Blue Cross Blue Shield home upgrade program. When asked to compare the DEC Program to the other weatherization and home upgrade programs they participate in, this agency staff member reported there were no major implementation differences, aside from the State WAP eligibility guidelines surrounding heating fuel type.

- **Participants are also satisfied with all components of the program.** As shown in Figure 9, 94% of participants reported that they were satisfied with the program overall, and 93% reported that they were satisfied with the weatherization representative who installed the equipment.¹⁰ Moreover, across the measures we verified, most participants were satisfied with the equipment they received (ranging from 83% of those who received faucet aerators to 100% of participants who received LEDs and efficient heating systems). Common reasons for dissatisfaction with equipment include participants not satisfied with the performance of the equipment (low pressure from faucet aerators or showerheads) and not noticing a difference in their home following installation of air sealing or insulation.

¹⁰ Satisfied is defined as a rating of 8 to 10 on a scale of 0 to 10, where 0 means "not at all satisfied" and 10 means "very satisfied."

Figure 9. Participant Satisfaction with DEC Weatherization Program and Equipment



- **The DEC Weatherization Program helps to alleviate the biggest home and energy concern agencies reported their customers faced: high energy bills.** All interviewed agencies reported paying their energy bills was a key issue for their customers and saving money on energy bills was the most common motivator for participating in the program (reported by 42% of survey respondents). Survey results suggest the program is helping participants in this respect, with 73% of respondents reporting lower summer electricity bills and 58% of respondents reporting lower winter electricity bills following participation in the program.
- **The program is delivering substantial non-energy benefits to program participants including improved home comfort in the summer and winter, reduced draftiness, better lighting, and, to some extent, lower outdoor noise levels and home maintenance costs.** Several survey respondents also mentioned additional benefits they have experienced since participating in the program, including improved quality of life, safer homes, and increased water efficiency. Participating agencies can utilize this research as a way to market the program to hesitant clients.

5.3.6 Program Challenges and Opportunities for Improvement

While all interviewed agencies were highly satisfied with the program overall, most (4/6) also noted some challenges in program implementation. Two agencies reported they wished the program provided more funds to agencies, either through more measures covered by the program, such as stove or natural gas furnace replacements, or increased funds for health and safety repairs. Two agencies also noted they experienced internal staffing issues during the evaluation period, which prevented them from completing more projects. One of these agencies reported the biggest challenge they had was recruiting employees to perform the actual weatherization work on homes and explained that when they informed applicants of the nature of the job, many turned the position down. One agency reported a challenge for them was getting new participants to provide firsthand testimonials for use in marketing materials. This agency staff member explained that new participants were often wary of letting others know they participated in the program because “you don’t want everybody to know that you got your heating system fixed because they might come steal it.”

Interviewed NCCAA and TRC staff acknowledged one particular challenge for participating agencies is the reimbursement amount for energy saving measures, particularly for HVAC and refrigerator replacements. While the incentive amount for refrigerator replacements recently increased, the incentive for HVAC replacements has not, and agencies struggle to pay for these measures in the allotted cost cap. Program administrators also noted that the inconsistent funding environment CAAs often have to deal with is a challenge, since the program year starts July 1 but CAAs do not receive state funds until October 1. CAAs would often have to lay-off staff during the summer because they simply do not have the funds available to spend on payroll.

Suggestions for Program Changes

When asked for suggestions on how Duke Energy could improve the program to be more effective in the future, most agencies (4/6) reported the program could be improved by providing program funds for more measures, such as stove/oven replacements, natural gas furnace replacements, or additional health and safety upgrades. Agency staff also suggested Duke Energy could increase program marketing efforts (2/6), provide educational materials to customers about the program and the benefits of energy efficiency in their homes (2/6), and provide additional training to agency staff (2/6).

Program administration staff suggested revising the fixed payment model and pivoting to a reimbursement model. For example, program administration staff suggested providing agencies up to \$4,000 for Tier II measures, and not just reimbursing a fixed cost for each unit of the approved measures each agency installs. They also suggest “stacking” Tier II and HVAC replacement dollars, so a single home could be eligible for \$4,000 in Tier II measures plus \$6,000 for an HVAC replacement.

Program administrators also suggest increasing health and safety funds. Agency staff cannot weatherize a home that is unsafe. Many homes are being left out of the program, due to lack of funds for needed health and safety improvements, and Duke Energy does not realize any savings from those homes. Programs like the HHF provide some support for health and safety, but many agencies have to fund these upgrades from their operating budget or another source so they can complete weatherization. Program administration staff suggest an HHF-type program that covers the DEC service territory to provide funding for health and safety upgrades.

6. Process Evaluation—Durham Pilot

In 2018, Duke Energy launched a new weatherization pilot based in Durham, North Carolina. The Durham Pilot provided weatherization services and health and safety upgrades to 206 income-qualified Durham residents between October 2018 and December 2019.

As part of our evaluation of the DEC Low Income Weatherization Program, we conducted a limited process evaluation of the Durham Pilot, addressing the following research objectives:

- How do program design, implementation, and participation of the Durham Pilot compare to the DEC Weatherization Program?
- What are the relative advantages and disadvantages of the two program designs?
- How do the two offerings compare in terms of per-home savings potential?

This limited process evaluation included an in-depth interview with pilot staff and a focused program-tracking database analysis to document program design, identify early implementation successes and challenges, and make comparisons to the Weatherization Program.

6.1.1 Pilot Overview

Duke Energy launched the Durham Pilot in 2018, with the intent to determine how and if the current DEC Weatherization Program design could be improved and expanded into Duke Energy Progress (DEP) service territory. A secondary intent of the pilot was to determine if a different funding model could be used to expand weatherization services into South Carolina, where current DEC Weatherization Program funds qualify as program income, which limits CAA participation in the program.

Duke Energy conducted this pilot in Durham, North Carolina due to a combination of factors. DEC ran the Low Income Neighborhood Energy Savers (NES) Program in Durham, and preliminary customer data collected from the NES Program indicated there was a high density of potentially qualified customers in the Durham area. Durham Pilot staff noted that many people who participated in the NES Program could derive additional benefits from weatherization services, and DEC would realize greater electric savings if they provided those services to customers. In addition, the program administrator, NCCAA, is headquartered in Raleigh, making the logistics of launching the pilot there appealing to pilot staff.

The Durham Pilot was designed to bring weatherization services to customers who may not have been able to receive these services from a CAA. The pilot had eligibility requirements similar to Tier II of the Weatherization Program (income of no more than 200% of Federal Poverty Guidelines and energy usage of at least 7 kWh per square foot) and offered the same measures (prioritizing insulation, air sealing, and duct sealing, and offering baseload lighting and DHW measures). The pilot did not offer a Tier I option for lower usage customers. Similar to the Weatherization Program, it offered HVAC upgrades and replacements as part of Tier II services as well as refrigerator replacements.

6.1.2 Comparison to DEC Weatherization Program

Although DEC designed the Durham Pilot to provide the same services to customers as the DEC Weatherization Program, there are a few key differences in the design and implementation of the two offerings:

- **Program Implementation.** The Durham Pilot relied on Duke Energy staff and NCCAA, rather than agencies, to complete weatherization projects. Durham Pilot staff were responsible for providing all funding, program services, and oversight for each Durham Pilot project. Pilot staff hired independent, qualified contractors to go to homes to complete assessments and install energy saving measures. Durham Pilot staff were also responsible for following up with participants on any issues.
- **Program Eligibility.** Participation in the pilot was limited to income-eligible customers with energy usage of at least 7 kWh per square foot. Unlike the Weatherization Program, the pilot did not offer a Tier I option for lower usage customers.
- **Marketing and Outreach.** The Durham Pilot conducted proactive marketing and outreach for the program by microtargeting NES Program participants and other potentially qualified customers with letters and other program materials. This is in stark contrast to the Weatherization Program, wherein CAAs are responsible for marketing the program. Durham Pilot staff reported that “with this design, we have the information where we’re going to the customers versus sitting back and waiting for the customers to come to us.” Durham Pilot Staff also reported that qualified customers were often not aware of the pilot or that Duke Energy provided energy saving programs like this.
- **Customer Prioritization:** The Durham Pilot served qualified customers on a first come, first served basis. In contrast, CAAs operating through the Weatherization Program must prioritize homes with lead, small children, or elderly occupants when providing weatherization services due to DOE and State WAP requirements. This can result in some customers waiting several years for vital weatherization services. Durham Pilot staff recalled a particular customer, a veteran, who waited nine years for weatherization services since they did not meet the high priority criteria.
- **Measure Cost:** Duke Energy paid the full cost of each measure in the Durham Pilot, compared to a percentage of each measure in the Weatherization Program. CAAs are responsible for covering the remainder of the measure cost, either through funds from another program (such as State WAP or LIHEAP) or through their operating budget. While this funding approach is less cost-effective than rebating a portion of the cost, it allowed for higher percentage of more comprehensive projects than the Weatherization Program. It might also allow Duke Energy to expand weatherization services into DEP territory and South Carolina. Weatherization Program funds qualify as program income in South Carolina, which affects federal funding for CAAs in the state and prevents them from participating in the program.

6.1.3 Early Successes and Pilot Advantages

Although pilot staff did not formally survey customers, they reported high participant satisfaction with the program and the services they received. The program served customers who, according to pilot staff, may have had to wait for years before receiving services from the DEC Weatherization Program. Interviewed staff relayed participant feedback that the contractors were respectful, worked hard to help them, and often understood the participants’ situation. Pilot staff were commonly told by participants that they did not know Duke Energy offered any programs of this nature and felt they could trust program staff. As one pilot staff member put it, “We can count on one hand the number of issues that arose, and those issues that did arise were resolved pretty quickly.”

Interviewed pilot staff remarked that it was easier to work directly with the program administrator, as opposed to delegating the work to CAAs. Additionally, Pilot staff identified having access to important customer data as another advantage of not relying on CAAs for implementation. This customer data enabled Pilot staff to identify and target customers most in need of weatherization services and provide education on ways to lower energy

costs and burden. Pilot staff also reported that customers may be hesitant to participate in the DEC Weatherization Program due to the bureaucracy associated with applying for a federal or state assistance program. Since the Durham Pilot did not leverage DOE or State WAP projects, the administrative burden on customers was greatly reduced.

6.1.4 Pilot Challenges

Although Durham Pilot staff were generally satisfied with how the Pilot performed, they did encounter a few implementation challenges. Some customers (about 5% of applicants) who made initial contact with Durham Pilot staff did not follow up with their information, which left Pilot staff uncertain if these customers were still interested in the program. Program staff also reported it was a challenge to get some qualified customers to schedule their in-home assessment with a qualified contractor. Program staff sent letters to customers informing them they would lose their spot in the program if they did not make an appointment.

Another issue for the Durham Pilot was having to turn down customers because the health and safety upgrades their homes required exceeded the resources of the program. This is a common issue for many weatherization programs, including the Weatherization Program, and the Durham Pilot staff partnered with other programs and agencies such as Habitat for Humanity and the HHF to provide health and safety upgrades for many participants.

Finally, the funding approach of covering the full project cost without contributions by agencies might make this program design difficult to implement on a larger scale.

6.1.5 Pilot Participation and Outcomes

The Durham Pilot served 206 customers between October 2018 and December 2019. In total, the pilot funded 148 Tier II projects, including 52 HVAC replacements, and replaced 123 refrigerators. The pilot partnered with the HHF to provide up to \$3,000 for health and safety upgrades before providing weatherization services. The pilot did not have any savings or participation goals, nor did pilot staff have any expectations of how the pilot would perform.

Durham Pilot staff did not directly compare participant characteristics or pilot activity to the Weatherization Program, and limited data prevents a full savings comparison between the two offerings. As part of our limited process evaluation, we analyzed program tracking data and compared key participant metrics across the two offerings. Key differences include:

- Participants in the Durham Pilot, on average, had slightly smaller homes and slightly higher energy use intensities.
- A smaller percentage of Durham Pilot participants have electric heat.
- A larger percentage of Durham Pilot participants live in multifamily homes.

Table 19. Comparison of Participant Characteristics

Participant Metrics	Durham Pilot (N=206)	Weatherization Program (N=1,706)
Average Annual Income	\$20,138	\$17,477
Average Square Footage	1,189	1,311
Estimate Annual Electricity Usage (kWh)	13,808	14,030
Estimated Energy Use Intensity (kWh/sqft)	11.6	10.7
Participants with Electric Heating	57%	65%
Participants in Multifamily Homes	19%	5%
Participants in Single Family Homes	81%	95%

While a full savings comparison between the pilot and the Weatherization Program was not possible within the scope of this evaluation, a comparison of the types of projects completed through the two offerings and the measure mix provides interesting insights into potential savings. It should be noted, however, that these insights are merely directional and intended for guidance purposes only.

Table 20 compares the percentage of participants who completed various types of weatherization projects. As noted above, the pilot did not offer a Tier I option, while 10% of Weatherization Program participants completed a (lower-savings) Tier I project. While a higher percentage of Weatherization Program participants completed a Tier II project (81% compared to 72%), pilot Tier II projects were more likely to include both weatherization measures and an HVAC replacement/upgrade (34% compared to 6%). In addition, a much higher percentage of pilot participants received a new refrigerator (60% compared to 24%), and more than half of them also completed a Tier II project (similar to Weatherization Program refrigerator recipients). This comparison suggests a higher savings potential (based on project type alone) for pilot participants compared to Weatherization Program participants.

Table 20. Comparison of Project Types

Project Type	% of All Participants	
	Durham Pilot (N=206)	Weatherization Program (N=1,706)
Tier I	0%	10%
Tier II	72%	81%
<i>Wx Measures & HVAC Replacement/Upgrade</i>	34%	6%
<i>Weatherization Measures Only</i>	65%	77%
<i>HVAC Replacement/Upgrade Only</i>	1%	17%
Refrigerator Replacements	60%	24%
<i>Refrigeration Replacement & Weatherization</i>	52%	55%
<i>Refrigerator Replacements Only</i>	48%	45%

A comparison of measures included in Tier II projects (see Table 21) shows additional differences between the pilot and the Weatherization Program. While both offerings provided most Tier II participants with air sealing and insulation, pilot participants were less likely to receive duct system insulation/sealing and much

less likely to receive water heating measures and weather stripping. No pilot Tier II participants received a heating system tune-up, compared to 27% of Weatherization Program participants. On the other hand, higher shares of pilot participants received lighting measures (57% compared to 35%) and HVAC replacements/upgrades (35% compared to 7%).

Given the relatively high savings impact of air sealing, insulation, and duct sealing/insulation, and the significant savings associated with HVAC replacements/upgrades, this comparison suggest a savings potential of the pilot on par with or even higher than for the Weatherization Program.¹¹ However, it also appears that some opportunities for savings might have been missed as few pilot participants received water heating measures, weather stripping, and heating system tune-ups. Given that the pilot targeted Durham, NC—an area previously served by the NES Program, which offered some of the same measures—it is possible that some of the participants not provided with these measures did not have a need for them.

Table 21. Comparison of Tier II Measure Mix

Measure Category	% of Tier II Participants	
	Durham Pilot (N=148)	Weatherization Program (N=1,387)
Air Sealing	92%	97%
Insulation	90%	91%
Duct System	65%	74%
Lighting	57%	35%
HVAC Replacement/Upgrade	35%	7%
Water Heating	22%	70%
Weather Stripping	9%	59%
Heating System Tune-Up	0%	27%

¹¹ It should be noted that savings from many of these measures depend on installed quantities as well as home characteristics, such as space and water heating fuel types. Detailed consideration of these factors was out of the scope of this analysis.

7. Key Findings and Recommendations

During the evaluation period, 1,706 households participated in the Weatherization Program, completing over 2,000 projects. The majority of participants (81%) completed a Tier II project; only 10% of participants completed a Tier I project. In addition, 24% received a replacement refrigerator, either as a stand-alone measure (8%) or in combination with Tier I or Tier II services (15%).

7.1 Key Impact Findings

Based on our impact analysis, we estimate that the projects completed during the evaluation period generate close to 3.2 million kWh of annual energy savings, 539 kW of annual summer coincident demand savings, and 935 kW of annual winter coincident demand savings. Tier II participants account for the largest share to program-level savings (89%) while Tier I participants and refrigerator replacements account for 1.3% and 9.6%, respectively, of total program energy savings.

Table 22 presents annual per-household and program-level net ex post savings for the evaluation period.

Table 22. Summary of Impact Results

Project Type	Number of Participants	Net Annual Savings Per Household			Net Annual Program Savings		
		Energy (kWh)	Summer Coincident Demand (kW)	Winter Coincident Demand (kW)	Energy (kWh)	Summer Coincident Demand (kW)	Winter Coincident Demand (kW)
Tier I	176	241	0.0724	0.0416	42,398	12.7	7.3
Tier II	1,387	2,042	0.3544	0.6438	2,832,531	491.5	892.9
Refrigerator Replacement	404	758	0.0864	0.0864	306,097	34.9	34.9
Total ^a	1,706				3,181,027	539.2	935.2

^a The total number of unique participants is smaller than the sum of project types since some households complete more than one project.

7.2 Key Process Findings

The process evaluation found that the DEC Weatherization Program continues to benefit from previously established relationships, implementation processes, and program-tracking systems. Program and implementation staff reported no major changes to the program since the previous evaluation aside from the new participation channel established in 2018. Participating agencies also reported minimal changes to how they implement and participate in the Weatherization Program, and many reported the DEC funds allow them to complete more weatherization jobs than they would have otherwise.

Key process findings include:

- **Program Participation.** Participation in the Weatherization Program has been increasing steadily since the program began in 2015. Agencies work hard to inform clients about the program through multiple advertising channels (newspaper ads, in-person events, agency websites, etc.) and half of interviewed agencies indicated the number of projects they complete each year is increasing.
- **New Participation Channel.** Prior to 2018, agencies could only submit projects originally funded by the State WAP for reimbursement from Duke Energy. Now, agencies may submit for reimbursement

projects they originally funded through their operating budget or another source. This opened the possibility of non-CAA organizations, such as non-profit organizations, to participate in the program and bring Weatherization Program services to their clients. Half of the agencies we interviewed indicated they had used this new participation channel. One agency, a non-profit organization, indicated they used this participation channel exclusively and only performed refrigerator replacements since their organization was not equipped to perform more extensive weatherization on clients' homes.

- **Satisfaction.** The process evaluation showed high satisfaction with the Weatherization Program. Interviewed agency staff often provided unprompted praise for the program implementation team and underscored the importance of the program to their clients. Agencies found the logistical elements of the program—including program organization, communication, and reporting—to be key program strengths. Participants were also highly satisfied with the program overall. A key concern for participants is high energy bills, and survey results suggest the program is helping participants in this respect, with 73% and 58% of respondents reporting lower summer and winter electricity bills, respectively, following participation in the program.
- **Non-Energy Impacts.** In addition to lowering energy bills, the Weatherization Program provides substantial non-energy benefits to participants including improved home comfort in the summer and winter, reduced draftiness, and better lighting. To a lesser extent, survey respondents also reported lower outdoor noise levels and home maintenance costs, improved quality of life, safer homes, and increased water efficiency.
- **South Carolina Policy Barriers.** Despite the new participation channel—introduced in 2018 to encourage participation by South Carolina agencies—barriers to program participation remain high in South Carolina, and no projects were completed in the state during this evaluation period. While the new participation channel has not yet resulted in program participation in the state, program staff continue to conduct outreach and provide additional support to South Carolina agencies and to encourage future program participation.
- **Durham Pilot.** Between October 2018 and December 2019, Duke Energy offered a weatherization pilot in Durham, North Carolina, which served a total of 206 customers. One goal of this pilot was to determine if the current DEC Weatherization Program design and funding model could be improved to expand program services to South Carolina and into the Duke Energy Progress (DEP) service territory. The limited process evaluation of the Durham Pilot found key differences between the pilot and the Weatherization Program in program eligibility, implementation, and measure mix:
 - Not relying on agencies to implement the program made the Durham Pilot implementation smoother and more flexible, and access to customer data allowed Pilot staff to target the program to the customers who needed it most. Since the Durham Pilot was entirely funded by DEC, participants did not need to spend time completing federal or state assistance program applications, which greatly reduced administrative burden on participants.
 - Compared to DEC Weatherization projects in the evaluation period, Durham Pilot projects were more likely to include both weatherization measures and an HVAC upgrade. Additionally, Durham Pilot participants were more likely to receive a refrigerator replacement. Based on the measure mix, we believe that the Durham Pilot has the potential to provide per household savings on par with, or possibly greater than, the savings estimated for the DEC Weatherization Program. Since this evaluation did not include a formal impact assessment, however, more rigorous impact analysis would be required to quantify the savings of the Durham Pilot.

Overall, pilot staff were highly satisfied with the performance of the pilot and indicated that participants were particularly grateful for program services they may have otherwise waited years to receive. Given the continuing policy barriers in South Carolina, despite the new participation channel, a program design similar to the Durham Pilot could be a good option for bringing weatherization services to customers in South Carolina and/or the DEP service territory.

7.3 Evaluation Recommendations

We have developed the following recommendations based on the results of our evaluation:

- **Consider tracking several additional parameters within the program-tracking system to enhance the accuracy of future deemed savings estimates.** Our deemed savings review (see Appendix B) identified a few parameters that are currently not tracked in program data: (1) pre- and post- blower door results in units of reduced cubic feet per minute (CFM); (2) presence or type of cooling at participating homes; (3) water heating fuel of participating homes; and (4) the installed location (e.g., bathroom, kitchen) for each low-flow faucet aerator. Some of this information is currently collected in the participant survey but having it in the program-tracking data for the population of participants would enhance the accuracy of future deemed savings estimates. We therefore recommend asking weatherization agencies to enter this information into the program's tracking system, if available.
- **Consider changing the reimbursement structure or increase reimbursement amounts.** The current Tier II incentive structure provides up to \$6,000 for Tier II projects. TRC and NCCAA indicated that agencies may struggle covering the cost of HVAC replacements with the current reimbursement amount, which has not increased since the program began in 2015. In addition, this reimbursement cap may also prevent participants from receiving weatherization services in addition to HVAC replacements/upgrades: Based on program-tracking data, only 6% of Tier II projects include both HVAC replacements/upgrades and other Tier II measures, compared to 34% in the Durham Pilot, which provided higher incentives. Agencies may be able to provide additional energy saving measures in Tier II homes, leading to deeper savings, if the overall Tier II incentive amount was increased.
- **Increase support to agencies in program marketing and outreach.** Agencies noted that communication and organization of the program were key strengths and frequently provided unprompted praise for staff at Duke Energy and NCCAA. One area agency identified for potential additional Duke assistance was marketing and outreach to help increase customer awareness of the program. This could be through information about the program on customer bills or on Duke Energy's website, or by developing testimonials from past program participants with examples of bill savings and other benefits—such as non-energy impacts (NEIs) reported by many surveyed participants—derived from their weatherization projects.
- **Explore options to increase the uptake of comprehensive weatherization projects through the new participation channel.** The new participation channel allows non-profit and other organizations to provide program services to customers who may not have been able to receive them otherwise. One objective of this channel was to overcome barriers to participation in South Carolina, as State policies prevent CAAs from participating in the program. Based on program-tracking data through April 2020, however, the new channel has not been successful in encouraging South Carolina organizations to participate in the program. In addition, information from our agency interviews suggest that some non-CAAs may not be equipped to facilitate the implementation of weatherization projects and thus limit their activity to equipment replacement. The program should continue to explore ways to promote participation in South Carolina, by identifying suitable partner organizations (with prior weatherization

expertise) and/or providing non-CAA organization with additional support in implementing weatherization services.

- **Consider expanding the Durham Pilot to include the South Carolina service territory.** Given the substantial policy barriers that continue to block participation in South Carolina, one way to provide weatherization upgrades to South Carolina customers is to introduce a program design similar to the Durham Pilot. Based on our review of project types and measures installed through the pilot, the savings potential for a program design similar to the pilot appears to be on par with, or even greater than, savings observed for the Weatherization Program. In addition, pilot participants and staff were very satisfied with the experience, and there were very few implementation challenges. If policy barriers persist, or the new participation channel fails to increase participation in South Carolina, this may be an option to expand services in the state.

8. Summary Form

Duke Energy Carolinas Low Income Weatherization Program

Completed EM&V Fact Sheet

Program Description

The DEC Weatherization Program reimburses local implementing agencies that have recently completed qualifying weatherization projects at Duke Energy customer homes. Electric conservation measures are provided at no cost to the customer. A tiered project structure is used to allocate reimbursements to agencies: Tier I applies to low usage homes and offers air sealing and low-cost energy efficiency upgrades (including lighting and low-flow aerators and showerheads); Tier II applies to higher usage homes and offers more comprehensive energy efficiency measures (including insulation and HVAC upgrades/replacements) in addition to Tier I measures.

Evaluation Methodology

The evaluation team performed a process and gross impact evaluation.

The process evaluation included a participant survey and interviews with participating surveys. We also performed a limited process analysis of the Durham Pilot.

The gross impact evaluation included an engineering analysis and a consumption analysis and leveraged results from the prior evaluation.

Impact Evaluation Details

- We determined annual per household energy savings for Tier II participants using consumption analysis.
- We determined annual per household energy savings for Tier I participants based on a combination of engineering analysis results and results from the prior evaluation.
- We estimated demand savings for Tier I and Tier II participants based on engineering analysis-based demand-to-energy ratios, applied to energy savings.
- We developed savings for refrigerator replacements and HVAC replacements/upgrades through engineering analysis.
- The engineering analysis applied deemed savings values to measures distributed and in service. In-service rates were calculated based on information collected in the participant survey.

Date	April 16, 2021
Region(s)	Duke Energy Carolinas
Evaluation Period	April 1, 2016–December 31, 2018
Annual kWh Savings (ex post net)	3,181,027 kWh
Coincident kW Impact (ex post net)	Summer: 539.2 kW Winter: 935.2 kW
Per Participant kWh Savings	Tier I: 241 kWh Tier II: 2,042 kWh Refrigerator: 758 kWh
Measure Life	Not evaluated
Net-to-Gross Ratio	N/A
Process Evaluation	Yes
Previous Evaluation(s)	June 2018

DSMore Table

9. DSMore Table

The Excel spreadsheet containing measure-level inputs for Duke Energy Analytics is provided below. Per-measure savings values in the spreadsheet are based on the impact analyses reported above. The evaluation scope did not include updates to measure life assumptions.



DSMore - DEC
Weatherization Proq

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Sep 16 2021

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