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Duke Energy Progress

2022 Non-Profit Low Income Weatherization Pay for Performance Pilot Program Evaluation Report – Final

August 16, 2022

Opinion Dynamics

Table of Contents

Opinion Dynamics

Table of Tables

1. Executive Summary

This report presents findings from the first evaluation of the Non-Profit Low-Income (LI) Weatherization (Wx) Pay for Performance Pilot Program (hereafter referred to as the "Pilot Program") administered by Duke Energy Progress (DEP). The participation period under evaluation is from the pilot's inception, January 1, 2019, through December 31, 2021. Due to the low number of participating households in the Pilot Program's population, the evaluation consisted of an engineering-based gross impact evaluation only. Also, as is customary for low-income programs, a net-to-gross analysis was not part of this evaluation, assuming that both free-ridership and spillover are zero.

This report includes a high-level description of the evaluation methodologies as well as results, findings, and recommendations.

1.1 Program Summary

The Pilot Program was originally approved on November 27, 2018, for a three-year term from January 1, 2019, through December 31, 2021. It was designed as an energy efficiency program to provide monetary incentives to local nonprofit weatherization assistance organizations involved in weatherizing residential low-income households in the Buncombe County, NC area.

The Pilot Program provided payments, based on deemed kilowatt-hour (kWh) savings, to local nonprofit organizations that provide weatherization and other energy-efficient upgrades to residential low-income households. Some of the qualifying energy-efficient measures for incentives included attic or wall insulation, air sealing, refrigerator replacements, lighting, or domestic water heating measures. The resulting payments were intended to assist the organizations in expanding the number of customers they serve through their programs. The Pilot Program also sought to provide additional funding to weatherization assistance organizations to encourage them to extend deeper energy efficiency saving into the projects they undertake.

Eligible participating households were identified by participating weatherization assistance and non-profit organizations using current United States Department of Energy (DOE) Low Income Home Energy Assistance Program (LIHEAP) grant requirements. Accordingly, all eligible participating households were required to have a household income less than 200% of the federal poverty guidelines, with the number of disabled, elderly, and minors in the household taken into consideration, as well as a high energy burden. To implement the program, DEP worked with two vendors, Community Action Opportunities (CAO) and the Green Built Alliance (GBA).

1.2 Evaluation Objectives

We established the following objectives for this evaluation:

- Review and update, as necessary, deemed savings estimates through a review of similar measure assumptions and calculations.
- Estimate program-level and average per household energy (kWh) and summer and winter peak demand (kW) savings.

1.3 Key Findings

During the evaluation period, 369 households participated in the Pilot Program, receiving just over 4,400 energy-saving measures. During the evaluation period, most participating households had work performed by GBA (72%) while fewer participating households had work performed by CAO (25%). A handful of households (3%) participated with both vendors, receiving different measures from each.

1.3.1 Impact Findings

Based on our impact analysis, we estimate that the projects completed during the evaluation period generated 474,964 kWh of annual energy savings, 76 kW of annual summer coincident demand savings, and 99 kW of annual winter coincident demand savings. Table 1 presents annual per-household and program-level ex post net savings for the evaluation period.

Table 1. Summary of Ex Post Impact Results

Savings Type	Unique Participating Households [a]	Energy Savings (kWh)	Summer Coincident Demand (kW)	Winter Coincident Demand (kW)
GBA	276	242,956	35.96	42.95
CAO	105	232,008	40.19	56.39
Total Program Savings	**369**	**474,964**	**76.15**	**99.34**
Average Savings per Household		1,287	0.21	0.27
Average Savings per Household without Refrigerator Replacements		1,242	0.20	0.26

[a] This refers to the number of unique participating households. The program-tracking data indicated that a total of 15 households participated on two separate occasions; 12 households participated once under each vendor while three households participated twice with the same vendor.

Table 2 presents the estimated ex post gross per-unit energy and demand savings for all measures installed through the Pilot Program

Table 2. Ex Post Per-Unit Deemed Savings Estimates

Measure Type	Per Measure Ex Post Savings		
	Energy Savings (kWh)	Summer Peak Demand (kW)	Winter peak Demand (kW)
Air Sealing			
Air Sealing – Space Cooling	571.93	0.2892	0.0000
Air Sealing – Space Heating	376.55	0.0000	0.2083
Insulation			
ACR Insulation – Space Cooling	87.05	0.0440	0.0000
ACR Insulation – Space Heating	382.16	0.0000	0.2114
Floor Insulation	876.49	0.0782	0.3993
Foundation Insulation	549.26	0.0490	0.2502
Wall Insulation – Space Cooling	94.27	0.0477	0.0000
Wall Insulation – Space Heating	439.68	0.0000	0.2432
Lighting			

Measure Type	Per Measure Ex Post Savings		
	Energy Savings (kWh)	Summer Peak Demand (kW)	Winter peak Demand (kW)
LEDs	31.42	0.0046	0.0023
Water Heating			
Faucet Aerators	32.72	0.0021	0.0043
Energy-Efficient Showerheads	206.82	0.0229	0.0458
Water Heater Pipe Insulation	441.26	0.0503	0.0503
Water Heater Tank Wraps	234.59	0.0268	0.0268
Water Heater Replacements	117.16	0.0300	0.0300
Refrigerator			
Refrigerator Replacements	860.57	0.0982	0.0982

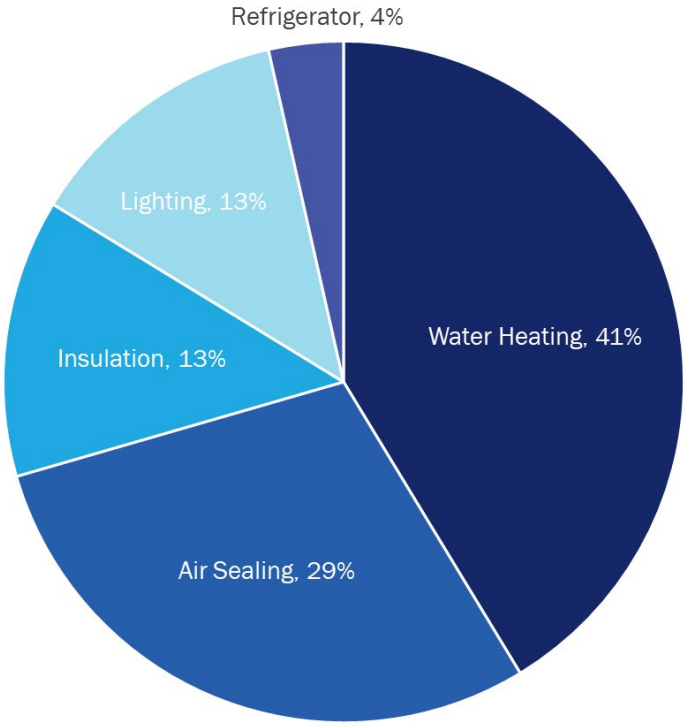
Table 3 shows that the most commonly installed energy-efficient measures, received by more than half of participating households, included energy-efficient lighting (LEDs, 85%), faucet aerators (75%), showerheads (69%), hot water pipe insulation (59%), and air sealing (50%). Fewer participating households received hot water heat tank wraps (30%), a type of home insulation (attic, ceiling, or roof, or "ACR", 12%; floor, 11%; foundation, 4%; or wall, 1%), or a large appliance replacement (refrigerator, 6%; water heater, 1%).

Table 3. Measure Mix by Participating Households

Measure Type	Number of Households	Proportion of Households
LEDs	313	85%
Faucet Aerators	275	75%
Energy-Efficient Showerheads	256	69%
Water Heater Pipe Insulation	218	59%
Air Sealing	186	50%
Water Heater Tank Wraps	109	30%
Insulation	64	17%
ACR Insulation	46	12%
Floor Insulation	41	11%
Foundation Insulation	13	4%
Wall Insulation	2	1%
Refrigerator Replacements	21	6%
Water Heater Replacements	4	1%
Total	**369**	**100%**

Based on our engineering analysis, the largest share of ex post Pilot Program savings during the evaluation period came from water heating measures (41%). Another 29% came from air sealing, 13% each came from insulation and lighting, and 4% came from refrigerator replacements (see Figure 1).

Figure 1. Measure Contribution to Energy Savings



1.4 Evaluation Recommendations

- **Support GBA in referring participating households to CAO to provide additional weatherization services and achieve deeper savings.** Only one of the two vendors, CAO, provided insulation services and large appliance replacements through the Pilot Program. Households served by CAO realized significantly larger per participating household savings compared to GBA, which does not provide those services. With additional program support, e.g., an information or referral sheet, GBA might be able to refer households they served to CAO for additional energy efficiency upgrades. Based on the program-tracking data, a small number of households served by GBA (5%) also took advantage of offerings from CAO, suggesting that there is some demand for the additional upgrades.
- **Consider tracking several additional parameters within the program-tracking system to enhance the accuracy of future deemed savings estimates.** Our deemed savings calculations identified a few parameters that are currently not tracked in program data: (1) the installed location (i.e., bathroom, kitchen) for each low-flow faucet aerator; and (2) the amount, or length, of water heater pipe insulation given to participating households. Including this information 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 a future consumption analysis for this program, if participation levels and available budgets allow.** Consumption analysis is the preferred methodology for evaluations of this type of program and the methodology used in the evaluation of the DEC LI Wx Program. If the Pilot Program continues to

be offered and is expanded going forward, we recommend evaluating future program activity via a consumption analysis to achieve more certainty in savings results than is possible via an engineering analysis.

2. Program Description

This section describes key elements of program design, implementation, and performance. The evaluation period addressed in this report is January 1, 2019, to December 31, 2021.

2.1 Program Design

The Pilot Program was originally approved on November 27, 2018, to help expand the number of customers served by organizations that provide weatherization and other energy-saving upgrades to residential low-income households. For the purpose of the Pilot Program, low-income was defined as households that qualify for the North Carolina's Weatherization Assistance Program.

The Pilot Program sought to provide monetary incentives to local non-profit weatherization assistance organizations serving Buncombe County, NC. It offered payments to these organizations based on deemed kilowatt-hour (kWh) savings from qualifying energy-efficient measures including attic or wall insulation, air sealing, refrigerator replacement, lighting, or domestic water heating measures. The Pilot Program also sought to provide additional funding to weatherization assistance organizations to encourage them to extend deeper energy efficiency saving into the projects they undertake.

The energy-efficient measures offered through the Pilot Program were largely comparable to those offered as part of the Duke Energy Carolina's (DEC) 2019–2020 LI Wx Program, which Opinion Dynamics evaluated in 2022 (hereafter referred to as the 2022 DEC LI Wx Program Evaluation).[1] The DEC LI Wx Program provides incentives for three types of projects: (1) Tier I, which covers items such as air sealing and low-cost energy efficiency upgrades like LEDs, domestic water heater tank insulation, low-flow shower heads, and faucet aerators; (2) Tier II, which covers Tier I measures plus insulation improvements; and (3) refrigerator replacements.

Table 4 compares the measures distributed in the Pilot Program compared to the counterparts in the 2022 DEC LI Wx Program Evaluation.

Table 4. DEP Pilot Program and DEC LI Wx Program Measure Comparison

DEP Measure	DEC Measure	DEC Program Tier
Air Sealing		
Air Sealing	Air Sealing	Tier I
Insulation		
ACR Insulation	Attic Insulation	Tier II
Floor Insulation	Floor Insulation	Tier II
Foundation Insulation		
Wall Insulation		
Lighting		
LEDs	LEDs (9-Watt)	Tier I
Water Heating		
Faucet Aerators	Faucet Aerators	Tier I
Energy-Efficient Showerheads	Energy-Efficient Showerheads	Tier I

[1] Opinion Dynamics. *Duke Energy Carolinas Low Income Weatherization Program Evaluation Report*. Forthcoming.

DEP Measure	DEC Measure	DEC Program Tier
Water Heater Pipe Insulation	Water Heater Pipe Insulation	Tier I
Water Heater Tank Wraps	Water Heater Tank Wraps	Tier I
Water Heater Replacements		
Refrigerator		
Refrigerator Replacements	Refrigerator Replacement	Refrigerator Replacement

2.2 Program Implementation

During the evaluation period, eligible participating households were identified by participating weatherization assistance and non-profit organizations using current DOE LIHEAP grant requirements. Accordingly, all eligible participating households were required to have a household income less than 200% of the federal poverty guidelines, with the number of disabled, elderly, and minors in the household taken into consideration, as well as a high energy burden.

To implement the program, DEP worked with two vendors, CAO and the GBA, both of which signed onto the program in early 2019. CAO is a weatherization provider located in Asheville, NC who has contracts with the North Carolina Weatherization Assistance Program and with the Department of Energy. They provide weatherization services for several counties in the western part of the state. GBA, also located in Asheville, NC, is a nonprofit organization; though GBA is not a dedicated weatherization provider, they complete weatherization and home-improvement work primarily in Buncombe County. Both vendors stopped work in March 2020 due to the COVID-19 pandemic but resumed field work by June 2020. Since returning to field operation the vendors experienced minimal issues related to COVID-19 or otherwise.

In October 2021, program staff filed a request to extend the Pilot Program into the 2022 year. The request was approved and the Pilot Program was set to continue through June 2022.

2.3 Program Performance

During the evaluation period, the program served 369 unique households, which received just over 4,400 energy-saving measures. The majority of participating households had work performed by the GBA (72%); far fewer participating households had work performed by CAO (25%) with several household participating with both vendors (3%).

Based on the impact analysis, the program achieved an average estimated savings of 1,287 kWh per participating household. Table 5 summarizes program participation as well as estimated ex post program energy and demand savings, for the program overall during evaluation period and per household.

Table 5. Summary of Ex Post Impact Results

Savings Type	Unique Participating Households [a]	Energy Savings (kWh)	Summer Coincident Demand (kW)	Winter Coincident Demand (kW)
GBA	276	242,956	35.96	42.95
CAO	105	232,008	40.19	56.39
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[a] This refers to the number of unique participating households. The program-tracking data indicated that a total of 15 households participated on two separate occasions; 12 households participated once under each vendor while three households participated twice with the same vendor.

3. Overview of Evaluation Activities

3.1 Program Staff Interviews

Opinion Dynamics conducted an in-depth interview with Duke Energy program staff in February 2022. The main purpose of the interview was to gain insight into program design and implementation processes and to develop research objectives for the evaluation.

3.2 Program Materials and Tracking Data Review

Opinion Dynamics reviewed the Pilot Program's tracking database and prepared it for use in the engineering analysis and to characterize participation in terms of measure mix, program activity by the two vendors, and other aspects that might provide insights into the program's achieved savings. As part of this analysis, we compared key program metrics, such as measure mix, with the 2022 DEC LI Wx Program Evaluation.

3.3 Deemed Savings Values Update

This evaluation updated ex ante deemed savings values, received from Duke Energy, leveraging the 2022 DEC LI Wx Program Evaluation as well as DEP and Pilot Program-specific information (from the program-tracking database). For each measure, we reviewed the ex post deemed savings parameters from the DEC evaluation and customized them with data from the Pilot's program-tracking data, or other DEP-specific data sources, when possible.

3.4 Engineering Estimate of Program Savings

We used the information developed in the previous step, combined with in-service rates (ISRs) leveraged from the 2022 DEC LI Wx Program Evaluation and the Pilot Program participation data, to (1) develop program-level savings during the span of the Pilot Program, and (2) calculate the average annual per household savings.

4. Gross Impact Analysis

4.1 Methodology

The gross impact analysis for the Pilot Program consisted solely of an engineering-based impact estimation.[2] The engineering-based evaluation

- Leveraged ISRs from the 2022 DEC LI Wx Program Evaluation;
- Customized ex post deemed savings values from the 2022 DEC LI Wx Program Evaluation with DEP and program-specific information; and
- Estimated program-level and average per household energy (kWh) and summer and winter peak demand (kW) savings by applying the ISR and deemed savings estimates to the Pilot Program–specific data tracking.

Appendix A contains the impact analysis file for the DEP Pilot Program, including all inputs and calculations for the deemed savings update and the engineering analysis.

4.1.1 Key Participation Metrics

Opinion Dynamics examined and compared key program characteristics and measures of the Pilot Program to similar metrics developed for the 2022 DEC LI Wx Program Evaluation.

4.1.2 Installation, Verification, and Persistence

This evaluation did not include primary data collection to verify the installation and persistence of program measures. Instead, Opinion Dynamics used measure-level ISRs from the 2022 DEC LI Wx Program Evaluation. That evaluation verified the installation and operation of the comparable measures based on responses to a participant telephone survey; the survey asked participants to confirm the specific measures they received and whether they were installed at the time of the survey. Based on those survey responses, the ISRs were calculated as the number of measures in operation divided by the number of measures reported in the program-tracking data (see Equation 1).

Equation 1. In-Service Rate

$$ISR = \frac{Quantity\ in\ Service}{Quantity\ in\ Tracking\ Data}$$

We assumed an ISR of 100% for measures the participants generally have difficulty verifying: water heater pipe insulation and water heater tank wraps.

4.1.3 Deemed Savings Update

We updated ex ante measure-level deemed savings values received from Duke Energy by leveraging ex post deemed savings values from the 2022 DEC LI Wx Impact Analysis. Where possible, we updated parameters for each measure with DEP or program-specific inputs. Key updates included: average square footage of the home; average water heater tank capacity; average inlet water temperatures, heating degree days, cooling

[2] While consumption analysis is the preferred methodology for this type of program, use of this method was not feasible due to limited participation and evaluation budget.

degree days, full load heating hours, and full load cooling hours for representative cities across the DEP service territory; and the percentage of participating households with central cooling, electric heat, and electric water heating.

Appendix B contains the parameters underlying the updated deemed savings values.

4.1.4 Engineering Analysis

To develop the ex post program-level savings for the evaluation period, we used the formula shown in Equation 2. To calculate the average annual per customer savings, we divided the total savings by the number of unique customers served through the Pilot Program.

Equation 2. Program-Level Savings

$$Sav = \sum_{i=1}^{n} (Q_{dbi} \times ISR_i \times EST_i)$$

Where:

Sav = Total program-level savings

i = Program measures

Q_{dbi} = Database quantity of measure i

ISR_i = In-service rate for measure i

EST_i = Per unit deemed savings estimate for measure i (KW or kWh)

We then compared these values to ex ante savings and developed realization rates at the measure and program levels.

Given that this evaluation did not include a consumption analysis, but consumption analysis is the preferred methodology for evaluations of this type of program, we compared the engineering-based savings to consumption analysis result of the last DEC LI Wx Program Evaluation (finalized in April 2021 and covering program activity between April 2016 and December 2018).[3]

4.2 Results

4.2.1 Key Participation Metrics

During the evaluation period, 369 unique households participated in the Pilot Program. The majority of participating households had work performed by the GBA (72%); far fewer participating households had work performed by CAO (25%), though a handful received services from both vendors (3%).

The most common energy efficiency measures provided to participating households included LEDs (85%), faucet aerators (75%), showerheads (69%), hot water pipe insulation (59%), air sealing (50%), and hot water heat tank wraps (30%). Notably, these are all measures provided by both of the Pilot Program's vendors (shown in Table 6). Some households working with CAO also received insulation (17%)—including ACR insulation (12%), floor insulation (11%), foundation insulation (4%), and wall insulation (1%)—or refrigerator or water

[3] Consumption analysis results for the 2022 DEC LI Wx Program Evaluation are not yet available.

heater replacements (6% and 1%, respectively); GBA did not distribute these types of measures to any participating households during the evaluation period.

Table 6. Measure Mix by Participating Households by Vendor

Measure Type	Proportion of Households with GBA (n=276)	Proportion of Households with CAO (n=105)	Total Proportion of Households (n=369 [a])
LEDs	88%	69%	85%
Faucet Aerators	79%	58%	75%
Energy-Efficient Showerheads	72%	58%	69%
Water Heater Pipe Insulation	51%	75%	59%
Air Sealing	37%	84%	50%
Water Heater Tank Wraps	25%	39%	30%
Insulation	0%	61%	17%
ACR Insulation	0%	44%	12%
Floor Insulation	0%	39%	11%
Foundation Insulation	0%	12%	4%
Wall Insulation	0%	2%	1%
Refrigerator Replacements	0%	20%	6%
Water Heater Replacements	0%	4%	1%

[a] This refers to the number of unique participating households. The program-tracking data indicated that a total of 15 households participated on two separate occasions; 12 households participated once under each vendor while three households participated twice with the same vendor.

The Pilot Program provided incentive payments of $0.18/kWh, based on each measure's ex ante deemed savings, to the vendors who implemented various program measures. Table 7 shows the per measure and total incentive for the various measures offered through the program. Air sealing and LEDs accounted for the highest shares of incentives paid (36% and 21%, respectively) during the evaluation period.

Table 7. Incentives Paid Per Measure

Measure Type	Incentives Per Measure	Total Incentives
Air Sealing		
Air Sealing – Space Cooling	$10.44	$1,492.92
Air Sealing – Space Heating	$142.65	$26,390.25
Insulation		
ACR Insulation – Space Cooling	$34.52	$1,587.92
ACR Insulation – Space Heating	$172.61	$7,594.84
Floor Insulation – Space Heating	$85.29	$3,496.89
Foundation Insulation – Space Heating	$293.36	$3,813.68
Wall Insulation– Space Cooling	$37.91	$75.82
Wall Insulation– Space Heating	$203.32	$406.64
Lighting		
LEDs	$5.98	$16,026.40

Measure Type	Incentives Per Measure	Total Incentives
Water Heating		
Faucet Aerators	$3.55	$1,952.50
Energy-Efficient Showerheads	$12.12	$4,217.76
Water Heater Pipe Insulation	$12.36	$2,731.56
Water Heater Tank Wraps	$20.66	$2,251.94
Water Heater Replacements	$21.09	$84.36
Refrigerator		
Refrigerator Replacements	$216.00	$4,536.00
Total		**$76,659.48**

4.2.2 Installation, Verification and Persistence

This evaluation did not include primary data collection to verify the installation and persistence of program measures and instead used measure-level ISRs from the 2022 DEC LI Wx Program Evaluation. Table 8 shows the measure-level ISRs for each of the measures provided in the Pilot Program and the source of each value.

Table 8. Assumed First Year Measure In-Service Rates and Source

Measure Type	ISR	Source of ISR
Air Sealing		
Air Sealing	0.91	2022 DEC LI Wx Evaluation
Insulation		
ACR Insulation	0.98	2022 DEC LI Wx Evaluation; value for general insulation
Floor Insulation	0.98	
Foundation Insulation	0.98	
Wall Insulation	0.98	
Lighting		
LEDs	0.72	2022 DEC LI Wx Evaluation
Water Heating		
Faucet Aerators	0.63	2022 DEC LI Wx Evaluation
Energy-Efficient Showerheads	0.85	2022 DEC LI Wx Evaluation
Water Heater Pipe Insulation	1.00	Assumption[a]
Water Heater Tank Wraps	1.00	Assumption[a]
Water Heater Replacements	0.92	2022 DEC LI Wx Evaluation; value for heating systems
Refrigerator		
Refrigerator Replacements	0.92	2022 DEC LI Wx Evaluation

[a] Consistent with the 2022 DEC LI Wx Program Evaluation, we assumed an ISR of 100% for measures that participants generally have difficulty verifying.

4.2.3 Deemed Savings Update

As described above, we leveraged the measure-level ex post deemed savings values from the 2022 DEC LI Wx Evaluation but applied DEP and program-specific assumptions, where possible. Table 9 provides the

estimated ex post gross per-unit energy and demand savings for all measures installed through the Pilot Program compared to the corresponding ex ante per-unit values. To highlight differences, the table also shows the measure-level, per-unit realization rates. It should be noted that the reason for differences between ex ante and ex post values is unknown, as assumptions underlying ex ante values were not available (the evaluation scope did not include a review of ex ante assumptions but was limited to providing updated values based on prior evaluations of similar Duke Energy's residential programs).

Table 9. Ex Post Per-Unit Deemed Savings Estimates Compared to Ex Ante Projections

Measure Type	Per Measure Ex Ante Savings			Per Measure Ex Post Savings			Realization Rates		
	Energy Savings (kWh)	Summer Peak Demand (kW)	Winter Peak Demand (kW)	Energy Savings (kWh)	Summer Peak Demand (kW)	Winter peak Demand (kW)	Energy Savings (kWh)	Summer Peak Demand (kW)	Winter Peak Demand (kW)
Air Sealing									
Air Sealing – Space Cooling	57.99	0.0100	0.0200	571.93	0.2892	0.0000	986%	2892%	0%
Air Sealing – Space Heating	792.51	0.1700	0.2200	376.55	0.0000	0.2083	48%	0%	95%
Insulation									
ACR Insulation – Space Cooling	191.79	0.0400	0.0500	87.05	0.0440	0.0000	45%	110%	0%
ACR Insulation – Space Heating	958.93	0.2100	0.2700	382.16	0.0000	0.2114	40%	0%	78%
Floor Insulation	473.84	0.1000	0.1300	876.49	0.0782	0.3993	185%	78%	307%
Foundation Insulation	1,629.80	0.3500	0.4600	549.26	0.0490	0.2502	34%	14%	54%
Wall Insulation – Space Cooling	210.59	0.0500	0.0600	94.27	0.0477	0.0000	45%	95%	0%
Wall Insulation – Space Heating	1,129.54	0.2500	0.3200	439.68	0.0000	0.2432	39%	0%	76%
Lighting									
LEDs	33.20			31.42	0.0046	0.0023	95%	N/A	N/A
Water Heating									
Faucet Aerators	19.72	0.0100	0.0100	32.72	0.0021	0.0043	166%	21%	43%
Energy-Efficient Showerheads	67.33	0.0100	0.0100	206.82	0.0229	0.0458	307%	229%	458%
Water Heater Pipe Insulation	68.69	0.0100	0.0100	441.26	0.0503	0.0503	642%	503%	503%

Measure Type	Per Measure Ex Ante Savings			Per Measure Ex Post Savings			Realization Rates		
	Energy Savings (kWh)	Summer Peak Demand (kW)	Winter Peak Demand (kW)	Energy Savings (kWh)	Summer Peak Demand (kW)	Winter peak Demand (kW)	Energy Savings (kWh)	Summer Peak Demand (kW)	Winter Peak Demand (kW)
Water Heater Tank Wraps	114.75	0.0100	0.0100	234.59	0.0268	0.0268	204%	268%	268%
Water Heater Replacements	117.16	0.0300	0.0300	117.16	0.0300	0.0300	100%	100%	100%
Refrigerator									
Refrigerator Replacements	1,200.00	0.1000	0.1000	860.57	0.0982	0.0982	72%	98%	98%

4.2.4 Engineering Analysis

This section provides the results of the engineering estimate, including the total ex post energy and demand savings estimates for each measure offered by the Pilot Program. In addition, this section summarizes the total program and per household savings estimates, as well as the realization rates for the evaluation period.

Total Ex Post Program and Per-Household Savings

We calculated total ex post gross program savings for the evaluation period by multiplying the ISRs (shown in Table 8) and the ex post per-unit deemed savings values (shown in Table 9) by the respective measure quantities in the program-tracking database. As is customary for low-income programs, we assumed that both free-ridership and spillover are zero (i.e., a net-to-gross value of 1.0). As such, net savings are equal to gross savings.

Table 10 summarizes ex ante and ex post savings, and the resulting realization rates, by measure type. Based on the deemed savings and ISR results summarized above, for most measures, differences in ex ante and ex post savings are driven by updates to deemed savings values, with changes going in both direct directions. Application of ISRs always reduced ex post savings, relative to ex ante savings, with adjustments ranging from 63% for faucet aerators to 98% for insulation. The exception is for water heater pipe insulation, and water heater tank wraps, for which we assumed an ISR of 100%. Overall, estimated ex post savings exceed ex ante savings by 12% for energy savings and by 12% and 18%, respectively, for summer and winter demand savings.

Table 10. Engineering Estimate Total Ex Ante Savings, Ex Post Savings and Realization Rates

Measure Type	Total Ex Ante Savings			Total Ex Post Savings			Realization Rates		
	Energy Savings (kWh)	Summer Peak Demand (kW)	Winter peak Demand (kW)	Energy Savings (kWh)	Summer Peak Demand (kW)	Winter Peak Demand (kW)	Energy Savings (kWh)	Summer Peak Demand (kW)	Winter Peak Demand (kW)
Air Sealing									
Air Sealing	154,907	32.88	43.56	138,558	37.83	35.26	89%	115%	81%
Insulation									
ACR Insulation	51,015	11.08	14.18	20,299	1.97	9.07	40%	18%	64%
Floor Insulation	19,427	4.10	5.33	35,038	3.13	15.96	180%	76%	299%

Measure Type	Total Ex Ante Savings			Total Ex Post Savings			Realization Rates		
	Energy Savings (kWh)	Summer Peak Demand (kW)	Winter peak Demand (kW)	Energy Savings (kWh)	Summer Peak Demand (kW)	Winter Peak Demand (kW)	Energy Savings (kWh)	Summer Peak Demand (kW)	Winter Peak Demand (kW)
Foundation Insulation	21,187	4.55	5.98	6,962	0.62	3.17	33%	14%	53%
Wall Insulation	2,680	0.60	0.76	1,041	0.09	0.47	39%	15%	62%
Lighting									
LEDs	88,976	N/A	N/A	60,378	8.93	4.32	68%	N/A	N/A
Water Heating									
Faucet Aerators	10,846	5.50	5.50	11,311	0.74	1.48	104%	13%	27%
Energy-Efficient Showerheads	23,431	3.48	3.48	61,178	6.77	13.54	261%	195%	389%
Water Heater Pipe Insulation	15,180	2.21	2.21	97,518	11.12	11.12	642%	503%	503%
Water Heater Tank Wraps	12,508	1.09	1.09	25,570	2.92	2.92	204%	268%	268%
Water Heater Replacements	469	0.12	0.12	430	0.11	0.11	92%	92%	92%
Refrigerator									
Refrigerator Replacements	25,200	2.10	2.10	16,682	1.90	1.90	66%	91%	91%
Total Program Savings	**425,827**	**67.71**	**84.31**	**474,964**	**76.15**	**99.34**	**112%**	**112%**	**118%**

Savings Comparison by Vendor

As mentioned above, the vendors differed in the measures they offered through the program and, therefore, contributed different proportions of energy savings compared to the number of participating households that they served. The work performed by GBA contributed only 51% of the overall program savings even though GBA performed work with 75% of participating households. CAO, working with 28% of participating households, contributed to 49% of overall program savings. This difference was driven largely by CAO offering insulation (ACR, floor, foundation, or wall), refrigerator replacements, and water heater replacements, which combined accounted for approximately 17% of total program savings during the evaluation period.

Table 11 summarizes the total and per household Pilot Program energy and demand savings and further shows the contributions from both vendors.

Table 11. Engineering Estimate Total and Per Household Savings

Savings Type	Unique Participating Households [a]	Energy Savings (kWh)	Summer Coincident Demand (kW)	Winter Coincident Demand (kW)
GBA	276	242,956	35.96	42.95
CAO	105	232,008	40.19	56.39
Total Program Savings	**369**	**474,964**	**76.15**	**99.34**
Average Savings per Household		1,287	0.21	0.27
Average Savings per Household without Refrigerator Replacements		1,242	0.20	0.26

[a] This refers to the number of unique participating households. The program-tracking data indicated that a total of 15 households participated on two separate occasions; 12 households participated once under each vendor while three households participated twice with the same vendor.

Savings Comparison with 2021 DEC LI Wx Program Evaluation

Opinion Dynamics compared the per participating household energy savings estimated for the Pilot Program to those developed the 2021 DEC LI Wx Program Evaluation.[4] The 2021 DEC LI Wx Program Evaluation developed savings estimates for three types of projects:

- Tier I projects included air sealing and low-cost energy efficiency upgrades like LEDs, domestic water heater pipe insulation and tank wrap, low-flow shower heads, and faucet aerators.
- Tier II projects included Tier I measures plus insulation improvements and heating system replacements;
- Refrigerator replacements were evaluated separately from Tier I and Tier II projects.

Given the measures offered by the two Pilot Program vendors, savings realized by households served by GBA are more comparable to Tier I households in the 2021 DEC LI Wx Program Evaluation, while households served by CAO (excluding refrigerator replacements) are more comparable to Tier II households. It is important to note, though, that while these program elements are similar, they are not identical as some of the households served by CAO did not receive deeper savings measures and might have been classified as a Tier 1 project in the DEC LI Wx Program. However, this mapping provides a useful point of comparison between the two programs.

Table 12 summarizes our comparison of the per participating household savings estimated for the two programs.

[4] Impact analysis results for the 2022 DEC LI Wx Program Evaluation are not yet available.

Table 12. Average Per Household Savings by Program and Program Type

Pilot Program Project Type	Pilot Program Net Annual Savings Per Household			2021 DEC LI Wx Project Type	2021 DEC LI Wx Net Annual Savings Per Household		
	Energy (kWh)	Summer Coincident Demand (kW)	Winter Coincident Demand (kW)		Energy (kWh)	Summer Coincident Demand (kW)	Winter Coincident Demand (kW)
GBA	880	0.1303	0.1556	Tier I	241	0.0724	0.0416
CAO (without Refrigerator Replacements)	2,051	0.3646	0.5189	Tier II	2,042	0.3544	0.6438
Refrigerator Replacements	794	0.0906	0.0906	Refrigerator Replacement	758	0.0864	0.0864

Overall, there is strong alignment between per household savings estimated for Pilot Program's CAO participants and DEC Tier II participants as well as for refrigerator replacement savings estimated for the two programs. In contrast, estimated per household savings for GBA participants are substantially larger than Tier I savings from the 2021 DEC LI Wx Program Evaluation. A likely contributor to this difference is the measure mix realized by the two programs: Significantly more participants served by GBA received the various domestic water heating measures and LEDs, whereas more DEC Tier I participants received air sealing as well as weatherstripping and heating system tune-ups (both of which were not offered by the Pilot Program during the evaluation period (Table 13).

Table 13. Measure Mix Comparing Projects Completed with GBA in the Pilot Program and with Tier I in DEC LI Wx

Measure Type	Proportion of Households with GBA (n=276)	Proportion of Households with Tier I (n=176)
Domestic Water Heating	94%	31%
Faucet Aerators	79%	16%
Energy-Efficient Showerheads	72%	14%
Water Heater Pipe Insulation	51%	19%
Water Heater Tank Wraps	25%	21%
LEDs	88%	26%
Air Sealing	37%	96%
Weatherstripping		35%
Heating System Tune-Up		6%

4.3 References

In addition to materials provided by Duke Energy for the Pilot Program, we used the following sources in our gross impact analysis:

- ASHRAE Fundamentals 2021. Appendix: Design Conditions for Selected Locations. Chapter 14
- ENERGY STAR® Air Source Heat Pump Calculator
- Illinois Technical Reference Manual. Version 10.0. September 25, 2020.

- 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. Versions 9.0 and 10.0.
- Opinion Dynamics. Duke Energy Carolinas Low Income Weatherization Program Evaluation Report. April 2011. Covering program activity between April 2016 and December 2018.
- Opinion Dynamics. Duke Energy Carolinas Low Income Weatherization Program Evaluation Report. Forthcoming. Covering program activity between January 2019 and December 2020.

5. Key Findings and Recommendations

During the evaluation period, 369 households participated in the Pilot Program. The majority of participating households had work performed by the GBA (72%); far fewer participating households had work performed by CAO (25%), though a handful received services from both vendors (3%).

5.1 Key Impact Findings

Based on our impact analysis, we estimate that the projects completed during the evaluation period generated 474,964 kWh of annual energy savings, 76 kW of annual summer coincident demand savings, and 99 kW of annual winter coincident demand savings. Table 14 presents annual per-household and program-level ex post net savings for the evaluation period.

Table 14. Summary of Ex Post Impact Results

Savings Type	Unique Participating Households [a]	Energy Savings (kWh)	Summer Coincident Demand (kW)	Winter Coincident Demand (kW)
GBA	276	242,956	35.96	42.95
CAO	105	232,008	40.19	56.39
Total Program Savings	**369**	**474,964**	**76.15**	**99.34**
Average Savings per Household		1,287	0.21	0.27
Average Savings per Household without Refrigerator Replacements		1,242	0.20	0.26

[a] This refers to the number of unique participating households. The program-tracking data indicated that a total of 15 households participated on two separate occasions; 12 households participated once under each vendor while three households participated twice with the same vendor.

5.2 Evaluation Recommendations

We have developed the following recommendations based on the results of our evaluation to consider as the Pilot Program potentially transitions into a fully commercialized program:

- **Support GBA in referring participating households to CAO to provide additional weatherization services and achieve deeper savings.** Only one of the two vendors, CAO, provided insulation services and large appliance replacements through the Pilot Program. Households served by CAO realized significantly larger per participating household savings compared to GBA, which does not provide those services. With additional program support, e.g., an information or referral sheet, GBA might be able to refer households they served to CAO for additional energy efficiency upgrades. Based on the program-tracking data, a small number of households served by GBA (5%) also took advantage of offerings from CAO, suggesting that there is some demand for the additional upgrades.
- **Consider tracking several additional parameters within the program-tracking system to enhance the accuracy of future deemed savings estimates.** Our deemed savings calculations identified a few parameters that are currently not tracked in program data: (1) the installed location (i.e., bathroom, kitchen) for each low-flow faucet aerator; and (2) the amount, or length, of water heater pipe insulation given to participating households. Including this information 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 a future consumption analysis for this program if participation levels and available budgets allow.** Consumption analysis is the preferred methodology for evaluations of this type of program and the methodology used in the evaluation of the DEC LI Wx Program. If the Pilot Program continues to be offered and is expanded going forward, we recommend evaluating future program activity via a consumption analysis to achieve more certainty in savings results than is possible via an engineering analysis.

6. Summary Form

DUKE ENERGY PROGRESS
NON-PROFIT LOW-INCOME WEATHERIZATION PAY FOR PERFORMANCE PILOT PROGRAM
COMPLETED EM&V FACT SHEET

PROGRAM DESCRIPTION

The Non-Profit Low-Income Weatherization Pay for Performance Pilot Program administered by DEP provided monetary incentives to local non-profit weatherization assistance organizations providing service in Buncombe County, North Carolina. It provided payments to these organizations based on deemed kilowatt-hour (kWh) savings from qualifying energy efficient measures including insulation, air sealing, refrigerator replacement, lighting, and water measures.

Date:	July 28, 2022
Region(s):	Duke Energy Progress
Evaluation Period:	January 1, 2018 – December 31, 2021
Total kWh Savings (ex post net):	474,964 kWh
Coincident kW Impact (ex post net):	76.15 kW (Summer), 99.34 kW (Winter)
Measure Life:	Not Evaluated
Net-to-Gross Ratio:	N/A
Process Evaluation:	No
Previous Evaluation(s):	N/A

EVALUATION METHODOLOGY

The evaluation team performed an engineering-based gross impact analysis that leveraged results from the 2022 DEC Low-Income Weatherization Program Evaluation.

IMPACT EVALUATION DETAILS

- We leveraged measure-level ISRs that were calculated as part of the 2022 DEC Low-Income Weatherization Impact Analysis.
- We developed ex post deemed savings values based on results of the 2022 DEC Low-Income Weatherization deemed savings review, customized with DEP and Pilot program specific information.
- The engineering estimate applied ex post deemed savings values and ISRs to measures in the program-tracking database.
- We determined total program and per household energy savings for the Pilot Program and compared these to results from prior DEC Low Income Weatherization Program evaluations.

7. 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 gross and net impact analyses reported above. The evaluation scope did not include updates to measure life assumptions.

[DSMore Table provided in a separate file]

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