Opinion Dynamics

Boston | Headquarters

617 492 1400 tel
617 497 7944 fax
800 966 1254 toll free

1000 Winter St
Waltham, MA 02451

Duke Energy Carolinas (DEC) and Duke Energy Progress (DEP)

Low and Moderate Income Penetration Study

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Opinion Dynamics

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1. Executive Summary

This study characterizes Duke Energy's low and moderate income (LMI) customer base and examines their participation in Duke Energy's energy efficiency programs between 2013 and 2021. We consider the degree to which the LMI population is served by existing Duke Energy program offerings, barriers and drivers to participation, and impacts of participation among this population.

1.1 Study Objectives

The key objectives of the study are to

- Characterize LMI customer participation in Duke Energy's residential energy efficiency programs;
- Compare LMI customer participation to that of non-LMI customers;
- Understand participation predictors and characterize LMI participants;
- Identify drivers of and barriers to participation among LMI customers;
- Understand and characterize impacts of program participation, including changes in electric energy costs and LMI customer experiences; and
- Identify strategies to cost-effectively increase LMI customer participation through programmatic enhancements.

To achieve these objectives, Opinion Dynamics utilized multiple primary and secondary data sources including analysis of Duke Energy customer data, Duke Energy program tracking data, US census data, in-depth interviews with Duke Energy LMI customers, and surveys with Duke Energy program participants and non-participants. Our analytic activities included a descriptive and geospatial analysis of program participation, linear regression modeling of participation correlates, and modeling of participants' energy bills.

1.2 Key Findings

- LMI customers have different demographic and housing characteristics, on average, than non-LMI households. Our analysis of census, Duke participation, survey, and in-depth interview data reveals that these differences affect LMI customers' energy efficiency needs, program participation barriers and motivations, and the magnitude of program participation impacts.
- Our analysis of census data and neighborhood participation rates from 2013 through 2021 found that average annual participation in Duke Energy energy efficiency programs was slightly lower in neighborhoods that have a moderate to high percentage of LMI households compared to those with few LMI households. Program participation was lowest in neighborhoods that have a moderate percentage of low income household customers. In neighborhoods where between 40% to 50% of households are LMI, an average of 8.29% of households participated in Duke Energy programs each year compared to 8.99% in neighborhoods with a high percentage of LMI households (90% or more) and 10.48% of households in neighborhoods with few LMI households (less than 10%).
  - Both moderate and high LMI neighborhoods have lower participation rates in market rate programs (~ 8%) compared to low LMI neighborhoods (~10%). But in high LMI neighborhoods, a small but meaningful percentage of households (~1%) participate in Duke Energy's low income programs, which somewhat makes up for their lower participation in market rate programs. In

neighborhoods with a moderate percentage of LMI households, fewer participate in low income programs (less than 0.5%).

- We found a similar difference in participation rates in programs with high energy savings. We found that 2.9% of customers who live in neighborhoods with a high concentration of LMI households participate in high savings programs compared to 3.7% of customers who live in neighborhoods with few LMI households.

- Our analysis of results from participant and nonparticipant surveys finds that Duke Energy programs struggle to reach historically hard-to-reach and frequently disadvantaged populations, namely renters, residents of multifamily properties, and more transient populations. The majority of participants, both LMI and non-LMI, are homeowners and live in single family homes. Living in a rented or multifamily home compounds the participation barriers for LMI customers.
  - We found that LMI program participants were much more likely to own their homes than LMI non-participants. Just over half of LMI participants (52%) are homeowners compared to 15% of LMI non-participants. Similarly, just under two-thirds of LMI participants (64%) live in a single-family home compared to just over one-quarter of LMI non-participants (28%).
  - Non-LMI participants are also more likely to be homeowners compared to non-LMI nonparticipants (86% vs. 57%). Non-LMI participants are more likely to live in single family homes compared to non-LMI nonparticipants (81% vs. 53%).
- Nonparticipant survey results show that LMI customers have greater energy efficiency needs and concerns than non-LMI customers.
  - One-third of LMI nonparticipants (33%) said "a lot of things" in their homes could be made more energy efficient, compared to only 16% of non-LMI nonparticipants.
  - LMI nonparticipants were more concerned about their energy usage than non-LMI nonparticipants. Half of LMI nonparticipants (49%) were either "very" or "extremely concerned" about their household energy use, compared to slightly under one-third (30%) of non-LMI nonparticipants.
- Despite a greater need for energy efficiency improvements, participation barriers among LMI customers are more pronounced compared to non-LMI customers and include program awareness, knowledge, cost constraints, and being a renter. Our survey results suggests that, with the support of a program that addresses their barriers to structural upgrades, LMI nonparticipants would be likely to make energy efficiency improvements to their homes. However, barriers such as split incentives and limited financial resources may inhibit LMI customers from seeing high-savings programs as a realistic possibility for their household.
  - LMI nonparticipants are less likely to be aware of Duke Energy programs compared to non-LMI nonparticipants (40% vs. 64%). Nonparticipants had low awareness of energy efficiency opportunities in general, with LMI customers reporting lower awareness than non-LMI customers. Over half of LMI nonparticipants (55%) said they were either not at all knowledgeable or had only a little knowledge about ways to save energy in their homes compared to 45% of non-LMI nonparticipants.
  - More LMI nonparticipants say that they are "not at all likely" to make changes to their home to make it more efficient in the next year compared to non-LMI nonparticipants (43% vs. 28%).
  - When presented with specific offerings from Duke Energy, LMI nonparticipants were more likely than non-LMI nonparticipants to say they were "very" or "extremely" likely to participate in any type of Duke Energy program in the next two years. LMI nonparticipants were most interested in no-

cost or low cost upgrades such as lighting or free upgrades based on income and least interested in higher cost and higher savings opportunities such as heating and cooling system rebates.

- LMI and non-LMI nonparticipants have different barriers to program participation. LMI nonparticipants were more likely than non-LMI nonparticipants to say that the cost of participation, their lack of authority as a renter, and the COVID-19 pandemic were barriers to their participation.

- Our modeling of LMI customer energy bills before and after participation in Duke Energy programs, revealed modest electric bill savings for customers who participated in Duke Energy programs. Following program participation, the electric bills of LMI customers fell by an average $34 per year, or about a 2% annual bill reduction ($1,600 is the average annual bill for LMI participants).

- One in five LMI participants reported a consistent reduction in their electric bills after participating in a Duke Energy program, which is somewhat lower than what non-LMI participants reported (21% vs. 29%). Survey results and in-depth interviews with LMI participants report these reductions have a greater impact on their household finances given their lower incomes.

  - LMI participants are significantly more likely than non-LMI participants to indicate that they would not have been able to afford to pay their electric bills without the savings associated with their participation (42% vs. 10%). One participant reported, "My bill is a lot lower than what it was. I've been saving about $14 a month. If Duke had not put me in the program, my kids and I would've been without lights."

- LMI customers are satisfied with their program participation experience and are more likely to report non-energy impacts (NEI) from participation than non-LMI customers.

  - The most frequent impacts that LMI participants noticed were better light quality (65%) and more comfortable home temperatures during the summer (57%) and winter (50%).

1.3 Study Recommendations

Opinion Dynamics has the following recommendations for increasing LMI customer participation in Duke Energy programs.

- **Duke Energy should continue to offer low income programs in addition to their market rate offerings.** Duke Energy's low income programs play an important role in supplementing market rate programs in in neighborhoods with a high percentage of LMI customers.

- **Duke Energy should consider expanding their low income offerings to reach more low income customers outside of neighborhoods with a high concentration of LMI customers.** The neighborhood-based low income programs are less effective at reaching customers in neighborhoods that have a moderate yet still sizable percentage of low-income customers.

- **Duke Energy should utilize existing LMI networks and leverage word-of-mouth outreach from satisfied participants to increase program awareness and participation.** LMI participants report receiving critical energy and non-energy benefits due to participating in Duke Energy programs. Duke Energy could encourage past participants to share their stories with friends, family, and neighbors. Duke Energy could also consider featuring testimonials about the benefits of participation from past participants in marketing materials.

- **To increase program participation among LMI customers, Duke Energy should enhance their low income program efforts to reach the sub-segments of LMI customers who are most underserved, focusing on renters and multifamily residents.** LMI renters and residents of multifamily properties are less likely to participate than comparable owners and single-family customers. Program

enhancements could include outreach to landlord and property owners either directly or on behalf of tenants and adding measures to existing multifamily programs that would provide greater energy savings.

- **Duke Energy should consider either adding a program specifically for moderate income customers or programs that would reduce the up-front investments required for high savings programs.** Moderate income customers could benefit from an on-bill financing program that would spread initial upgrade costs out over time.
- **Duke Energy should consider prioritizing new program offerings that provide support for measures that LMI customers report as most needed.** LMI nonparticipants report that they could most benefit from upgrades to their HVAC equipment, home weatherization, and energy efficient windows.

2. Overview of Study Activities

Table 1 summarizes how the study activities support the study objectives. We utilized a multimethod approach, addressing study objectives through both primary research and analysis of secondary data to support a nuanced understanding that reflects trends in the larger data as well as the lived experiences of actual Duke Energy customers.

Table 1. Study Objectives and Activities

Study Activity	LMI Customer Characterization	Participation Levels and Characterization	Participation Drivers and Barriers	Participation Impacts	Increasing LMI Customer Participation
Data Ingestion and Processing	✓	✓	✓	✓	
Participation Analysis	✓	✓	✓		✓
LMI Participant Interviews and Vignettes		✓	✓	✓	✓
LMI Customer Surveys	✓	✓	✓	✓	✓
Customer Payment and Cost Analysis				✓	

2.1 Data Ingestion and Processing

We utilized multiple streams of data for this project. We reviewed, cleaned, and processed all data sources and created a central analytic database that we used for all project tasks. Table 2 summarizes the data streams utilized for the study.

Table 2. Data Streams and Sources

Data Stream	Purpose	Source	Time Period [a]	Level
Program Participation	Identify Duke Energy customers who participated in energy efficiency programs, including the date of participation, program name, measures received, and anticipated ex ante savings.	Duke Energy	2013–2021	Customer
Customer Accounts and Energy Consumption	Quantify the population of Duke Energy customers eligible to participate in Duke Energy programs over time, including characteristics such as location and household energy consumption.	Duke Energy	2013–2021	Customer
Customer Billing and Payments	Identify customers who are behind on their energy bills and/or have been disconnected due to nonpayment.	Duke Energy	2017–2021	Customer
American Community Survey (ACS)	Identify average sociodemographic and housing characteristics in the neighborhoods where Duke Energy customers reside.	Census Bureau	2015–2019 5-year ACS estimates	Census block group
LMI Categorization	Assign likelihood of LMI household status by assessing the proportion of households in	Department of Housing and Urban	Based on 2011-2015 ACS data [b]	Census block group

Data Stream	Purpose	Source	Time Period [a]	Level
	each neighborhood that meet LMI criteria based on area median income.	Development (HUD)		
Energy Burden	Measure average household energy burden in the neighborhoods where Duke Energy customers reside.	Department of Energy (DOE)	Based on 2014–2018 ACS data [b]	Census Tract

[a] For each data stream, we carefully considered data availability, analytic needs, and study budget when selecting the time period covered. Because of these considerations, the time period varies by data stream.

[b] Years are the most recent data available from the respective government agencies at the time of the study.

As noted in Table 2, this analysis was conducted at multiple levels. Where household-level data was available across Duke Energy customers, we leveraged that data. The study team was unable to access key information, including household income, demographic, and housing characteristics, at the household level, and therefore leveraged US census data in these cases.[1] Where census data was used for the analysis, customers were characterized based on the prevailing social and demographic attributes of their neighborhood rather than household-level data.

2.2 Participation Analysis

The purpose of the participation analysis was to characterize Duke Energy's LMI customer population, document program participation trends among this population, and identify how sociodemographic, housing, geographic, and other attributes interact with both LMI status and Duke Energy program participation.

The descriptive analysis explored the relationship between LMI status and program participation for each of the characteristics laid out in Table 3. While the analysis was ultimately completed at the neighborhood level, the table indicates whether each variable originated from individual, customer-level data, or neighborhood-level census data. Table 3 summarizes the household- and neighborhood-level attributes analyzed.

Table 3. Variables Assessed as Part of Participation Analysis

Variable	Household	Neighborhood
LMI Status		✓
Program Participation Rate (Any)	✓	
Program Participation Rate (High Savings Potential)	✓	
Average Ex Ante Savings	✓	
Average Energy Burden		✓
% Nonwhite Households		✓
% Owner Occupied Households		✓
% Single Family Households		✓
Median Household Income		✓
% Limited English Households		✓
% Households Without Internet Access		✓
Urban/Rural Status		✓
% Households with Electric Heating Fuel		✓

[1] Census data was incorporated at the most discrete geography available. For most variables, this was at the census block group (CBG) level. Some variables are only available at the census tract level.

Descriptive Analysis

We began the analysis by characterizing Duke Energy LMI customers and program participation trends among LMI customers compared to all Duke Energy customers. The analysis leveraged several analytic techniques including review of descriptive statistics, cross-tabulations, scatterplots, and correlations.

A key component of the descriptive analysis was defining LMI customers. Because household income data was not available for individual customers and LMI definitions are also dependent on household size, which was not available, we conducted our analysis at the neighborhood level using census block group and census tract data. We first had to determine an appropriate definition of the household income that qualifies as low or moderate income. We used the Department of Housing and Urban Development (HUD) guidelines to determine the percentage of households in each block group or tract that met the HUD definition of low or moderate income. The HUD definition uses area median household income rather than state or national income to account for regional differences. Table 4 summarizes how HUD defines low- and moderate-income households.

Once we determined the percentage of low- or moderate-income households in each block group and census tract, we assigned each block group and tract an LMI status based on the proportion of households in census unit that met HUD LMI criteria. Block groups and tracts with 80% or more of households below the low- and/or moderate-income threshold were considered LMI neighborhoods. Block groups and tracts with 20% or fewer households below the low- and/or moderate-income threshold were considered non-LMI neighborhoods. This allowed us to compare the participation trends and sociodemographic characteristics of the neighborhoods where the vast majority of households were LMI with those that were not LMI.[2]

Table 4. Low and Moderate Income Definitions

Income Group	Definition
Low Income	Up to 50% of the area median income
Moderate Income	Greater than 50% and up to 80% of the area median income

Note: For more information on HUD's LMI definitions, see: https://www.hudexchange.info/programs/acs-low-mod-summary-data/.

Once we defined LMI neighborhoods, we assigned each Duke Energy customer to a census block group and tract based on their service address. We assessed neighborhood participation rates over time, by program, and based on savings potential for each neighborhood to gain a deeper understanding of how LMI customer participation is distinct from that of other Duke Energy customers. Next, we explored the relationship between a variety of sociodemographic, housing, and customer-level attributes and incidence of program participation, both for Duke Energy customers overall and among LMI customers. The descriptive analysis provided an understanding of (1) which factors are related to participation, (2) how strong the relationship is between each factor and likelihood to participate, and (3) the direction of the relationship (i.e., whether the attribute is associated with more or less participation).

Geospatial Analysis

Geospatial analysis is an important tool for understanding how LMI household prevalence, program participation rates, and related factors vary across Duke Energy's territory. It can help identify underserved LMI communities as well as communities in which Duke Energy has achieved high participation rates among

[2] Because this approach is based on neighborhood-level data rather than household-level data, some actual LMI households will live in neighborhoods designated as non-LMI neighborhoods and vice versa. We expect that stronger relationships and differences would be detected with household-level data.

LMI and other hard-to-reach populations. We used Esri ArcGIS maps, embedded in a Microsoft Power BI dashboard, to create user-friendly, interactive maps that support a deeper understanding of how various sociodemographic and housing factors contribute to program participation rates, and how Duke Energy is performing in reaching these sub-populations across their territory. For the geospatial analysis, we used the results of the descriptive analysis to provide visual displays of the characteristics most correlated with energy efficiency program participation among LMI populations. We provide images of maps covering Duke Energy's entire territory in the body of the report and additional maps that zoom in on six urban areas in Appendix A.

Modeling

We estimated a linear regression model to identify the predictors of participation in Duke Energy programs. Due to a lack of household-level data, the analysis was conducted at the census block group level and included a range of housing, demographic, and energy consumption characteristics for each neighborhood. We ran separate models for high vs. low savings offerings as determined from ex ante savings data. We provide additional detail on data cleaning and modeling in Appendix B.

2.3 LMI Participant Interviews and Vignettes

To add depth to the insights developed through the participation analysis, we conducted in-depth interviews with 40 Duke Energy customers who participated in a Duke Energy program in 2020 or 2021 and live in neighborhoods where at least 80% of households meet LMI criteria.[3] Questions we explored through the interviews included the following:

- What are the housing characteristics of LMI participants? What key energy using systems do they rely on in their day-to-day life?
- What motivates LMI customers to take part in a Duke Energy program?
- How do LMI customers experience the process of participating in a Duke Energy program?
- What are the experiences of LMI customers after participating in a Duke Energy program? How does participation affect their energy affordability, comfort, health, and other factors?
- What are the sociodemographic characteristics of LMI participants and their households?

Participant interviews were fielded in May through June 2022. Interviewers utilized an open-ended approach, starting with more general questions and probing on areas the respondent did not bring up organically. This allowed us to understand what was most salient or important to each respondent while also gaining feedback on their full experience. Interviews were transcribed and coded by theme to identify patterns among respondent experiences. Additional details on the interview approach and administration are provided in Table 5.

Table 5. Participant Interviews Overview

Attribute	
Population Frame	Participants between January 2020 and December 2021 residing in census block groups where 80% of households or more are low- or moderate-income
Sampling Approach	Stratified Random Based on savings potential, jurisdiction, homeowner/renter status

[3] We included only 2020 and 2021 participants in the interviews to enhance recall.

Attribute	
Sample Size	13,203
Fielding Dates	May 23, 2022–July 18, 2022
Outreach Method	Email and phone
Incentive	$20 e-gift card[a]
Total Number of Completed Interviews	40

[a] Mailed option was provided for respondents without email access

From the 40 interviews conducted, we highlight the stories of five LMI participants who experienced non-energy impacts due to their participation in a Duke Energy program. Participant vignettes were selected to represent a range of installed measures, participant demographics, and experiences following program participation. The vignettes are included in Appendix E. In addition to the full participant vignettes, we also draw from the participant interviews throughout the report to provide examples of how non-energy impacts observed through the participant survey and other research tasks affect real Duke Energy customers.

2.4 LMI Customer Surveys

To further characterize LMI customers and identify their needs and their unique drivers and barriers to program participation, we conducted two survey efforts: an online survey with LMI customers who recently participated in one or more of Duke Energy's energy efficiency programs, and an online survey with LMI customers who have not participated. The surveys were sequenced to follow the participation analysis and in-depth interviews to allow for maximum integration of insights to-date. This allowed us to use the survey as a tool to verify and build on insights and hypotheses developed through the study to-date. In addition, insights gained from in-depth interviews with participants allowed us to construct the participant survey questions to focus on those participation drivers and impacts most relevant to Duke Energy's LMI customer population.

The participant survey focused on the following research questions:

- What are the housing characteristics of LMI participants?
- How do LMI customers become aware of Duke Energy programs?
- What motivates LMI customers to take part in Duke Energy programs?
- How do LMI customers experience the process of participating in a Duke Energy program?
- What are the experiences of LMI customers after participating in a Duke Energy program? How does participation affect their energy affordability, comfort, health, and other factors?
- What are the sociodemographic characteristics of LMI participants and their households?

The nonparticipant survey focused on the following research questions:

- What are the housing characteristics of LMI nonparticipants?
- How aware are nonparticipating LMI customers of Duke Energy programs? What are their current and potential sources of awareness?
- Why do LMI customers choose not to participate in Duke Energy programs? What are their barriers to participation?
- What are the attitudes of nonparticipating LMI customers towards energy efficiency?
- How interested are LMI customers in participating in Duke Energy programs? What do they see as potential benefits of participating in a Duke Energy program?

- What are the sociodemographic characteristics of LMI nonparticipants and their households?

Table 6. Participant and Nonparticipant Surveys Overview

Attribute	Participant Survey	Nonparticipant survey
Target Population	Duke Energy customers who (1) participated in a program in 2020 or 2021 and (2) live in a census block group with at least 70% LMI households [a]	Duke Energy customers who (1) have not participated in an energy efficiency program since 2013; (2) have had an active account with Duke Energy for at least one year; and (3) live in a census block group where at least 80% of households are LMI
Total Completes	538	643
LMI Completes	213	307
Survey Dates	8/2/2022–8/31/2022	8/4/2022–8/31/2022
Survey Mode	Web	Web
Outreach Mode(s)	Email	Mail and email
Incentive	None	$10 e-gift card (physical gift card available for respondents without email access)
Response Rate	4.2%	6.5%

[a] We included only 2020 and 2021 participants in the surveys to enhance recall.

2.5 Customer Payment and Cost Analysis

The purpose of the payment and cost analysis was to assess the impact of program participation on LMI customer bills. To support the analysis, we leveraged monthly billing data for participants. Our analysis included program participants who participated in Duke Energy's energy efficiency programs between 2017 and March 2020 and resided in census block groups that had at least 50% LMI customers. We further refined eligibility criteria to only include participants with anticipated savings of 250 kWh and higher. These choices were driven by both data availability and statistical modeling considerations. More specifically, we chose to include participants with savings over 250 kWh to ensure that bill impacts are detectable in the monthly billing data. Furthermore, we chose to exclude participants beginning in March 2020 due to changes in customer billing processes, including a moratorium on disconnections, as well as significant changes to customer energy usage patterns due to the COVID-19 pandemic, both of which are challenging to control for in the modeling process. Using the above criteria, we narrowed the subpopulation of participants to 105,327.

We performed billing analysis, which is a statistical analysis that examines a change in customer bills before and after program participation relative to the change in a comparison group's bills during the same periods. Prior to specifying the models, we performed a thorough cleaning of the billing data. We worked closely with Duke Energy to obtain billing data and assemble it to accurately reflect customer monthly bills, arrearages, and account for any nuances in bills or rates, such as removing participants on fixed payment plans. We checked the data for gaps and inconsistencies as well as for sufficiency. Among other checks, we ensured the participants retained for the analysis had sufficient pre- and post-participation billing data, the participation dates were accurate, and the consumption data was free of outliers, such as bill periods with unreasonably small or unreasonably large dollar amounts.

We leveraged a quasi-experimental approach to the evaluation by developing a comparison group of participants. Including a comparison group allowed us to control for changes in electric rates over time and changes in economic conditions and other non-program factors that might affect customer bills during the study period. We constructed a comparison group from nonparticipants customers residing in the same

census block group as participating customers. We deployed distance matching algorithms to select a subset of nonparticipants who were most like treatment participants in terms of their billing history in the pre-period to form a comparison group. We conducted an equivalency analysis to ensure equivalency between the treatment and the matched comparison customers.

We used a linear fixed effects regression model for this analysis. Fixed effects models capture the effect of time invariant household-specific characteristics and are the industry best practice approach to modeling program savings. We specified a variety of models ranging from simple pre-post models to more complex models incorporating a variety of terms to control for known sources of variation. We specified models separately for DEC and DEP, by state, and overall. We further developed separate models based on the anticipated depth of savings as well as the income characteristics of the census block groups where participants reside. Our final model specifications included weather—heating degree days (HDD) and cooling degree days (CDD)—as well as monthly dummy variables to further control for seasonal differences in bills.

Appendix C contains a detailed discussion of the billing analysis methodology, including data cleaning steps, comparison group selection and assessment of equivalency, modeling process, and the final model specifications and outputs.

3. Duke Energy Program Offerings

The study includes participation in nearly all of Duke Energy's residential low-income and market rate programs from 2013 to 2021, as outlined in Table 7.

Table 7. Duke Energy Programs Included in LMI Study

Program Names(s)	Territories Offered		Years Offered								
	DEC	DEP	2013	2014	2015	2016	2017	2018	2019	2020	2021
Market Rate Programs											
Appliance Recycling Program	✓	✓	✓	✓	✓	✓					
Free LED/CFL Program[a]	✓		✓	✓	✓	✓	✓	✓	✓	✓	
Home Energy House Call Residential Energy Assessments	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Home Energy Improvement Smart$aver HVAC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
K12	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Multifamily Residential EE Multifamily	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Online Savings Store	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
Residential New Construction		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Save Energy in Water Single Family Water Measures	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
Low-Income Programs											
Low-Income Weatherization	✓				✓	✓	✓	✓	✓	✓	✓
Neighborhood Energy Saver	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Weatherization Pay per kWh Pilot		✓						✓	✓	✓	✓

[a] The Free LED/CFL reached a large proportion of DEC customers between 2013 and 2020. Its wide reach contributes to discrepancies in participation rates between the DEC and DEP territories, and to a sharp decline in the participation rate among DEC customers when the program was discontinued in 2021. However, the program reached LMI and non-LMI customers at an approximately equal rate, and therefore its inclusion in the study does not contribute to differences in participation rates between these groups.

The study includes a wide range of residential programs for single family and multifamily homes, and existing and new construction. The programs included in the study include both free, low-cost, and rebated options and cover a range of measure types including lighting, water measures, envelope upgrades, and HVAC measures.

The study excludes the retail-based Residential Lighting Program due to the inability to trace lighting purchases back to individual Duke Energy customers. It also does not include Duke Energy's behavioral program, the My Home Energy Report Program due to the high rate of penetration and opt-out nature of the program (i.e., customers do not choose to participate).

4. Study Findings

4.1 Characterizing Duke LMI Customers

As of 2021, LMI households made up almost half (43%) of Duke Energy's customer base in the Carolinas. Over 2 million customers live in households that meet low- to moderate-income criteria based on their area median income and household size. The proportion of LMI customers are similar in Duke Energy Carolinas (DEC) and Duke Energy Progress (DEP) service territories. Because low-income households have access to some services and programs that moderate-income households do not, we summarize the distribution of Duke Energy customers in each group in Table 8.

Table 8. Estimated Prevalence of LMI Households in Duke Service Territory

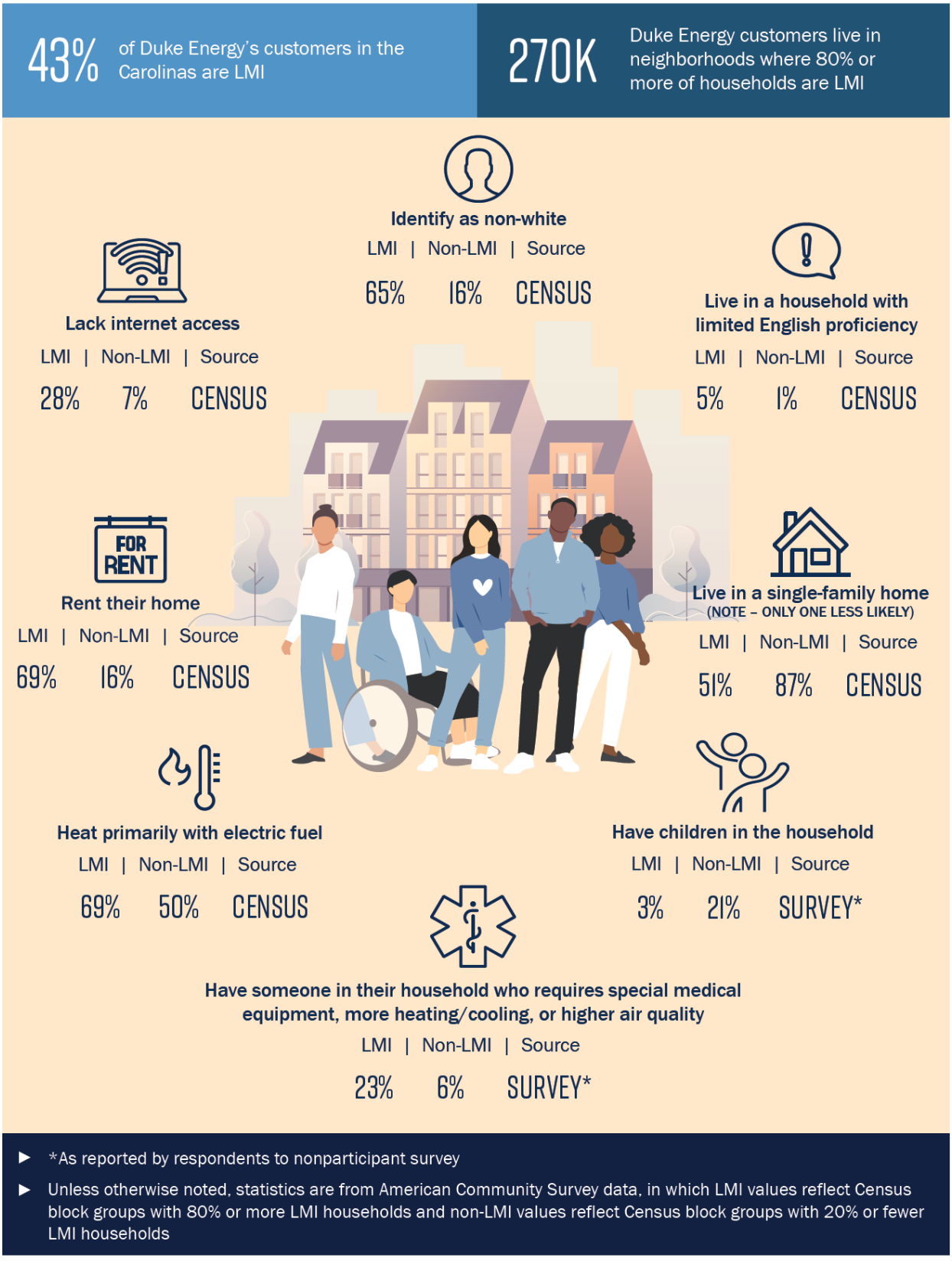
Household Status	All Duke		DEC		DEP	
	Count	%	Count	%	Count	%
Low or Moderate Income	2,060,000	43%	1,300,000	43%	760,000	43%
Low Income	*1,250,000*	*26%*	*790,000*	*26%*	*460,000*	*26%*
Moderate Income	*810,000*	*17%*	*510,000*	*17%*	*300,000*	*17%*
Non-LMI	2,740,000	57%	1,750,000	57%	990,000	57%
Total	4,800,000	100%	3,050,000	100%	1,750,000	100%

Note: Estimated customer counts rounded to nearest ten-thousand

In the absence of household-level data on LMI status for individual Duke Energy customers, we focus much of our analysis on block groups and census tracts in which 80% or more of all households were LMI. In the rest of the report, we refer to these high concentration census block groups and tracts as LMI neighborhoods. As of 2021, 270,000 (6%) Duke Energy customers lived in neighborhoods where at least 80% of households meet LMI criteria. Based on census data, households in these LMI neighborhoods were more likely than those in non-LMI neighborhoods (i.e., those with 20% or fewer LMI households) to live in a multifamily home, rent their homes, and heat with electric fuel. On average, LMI households were more diverse than non-LMI households, and situated in neighborhoods where a higher proportion of the population is non-white. Finally, households in LMI neighborhoods, on average, were more likely to face communication and enrollment barriers such as limited English proficiency and lack of internet access than those in non-LMI neighborhoods. (Figure 1).

While our analysis leverages census data, the trends in demographic and housing characteristics observed at the neighborhood level were generally corroborated in household-level data collected from survey respondents (Appendix D). Figure 1 summarizes Duke's LMI customer characteristics as observed in both census and household data for LMI neighborhoods compared to non-LMI neighborhoods. These characteristics are explored in more detail in the remainder of this section.

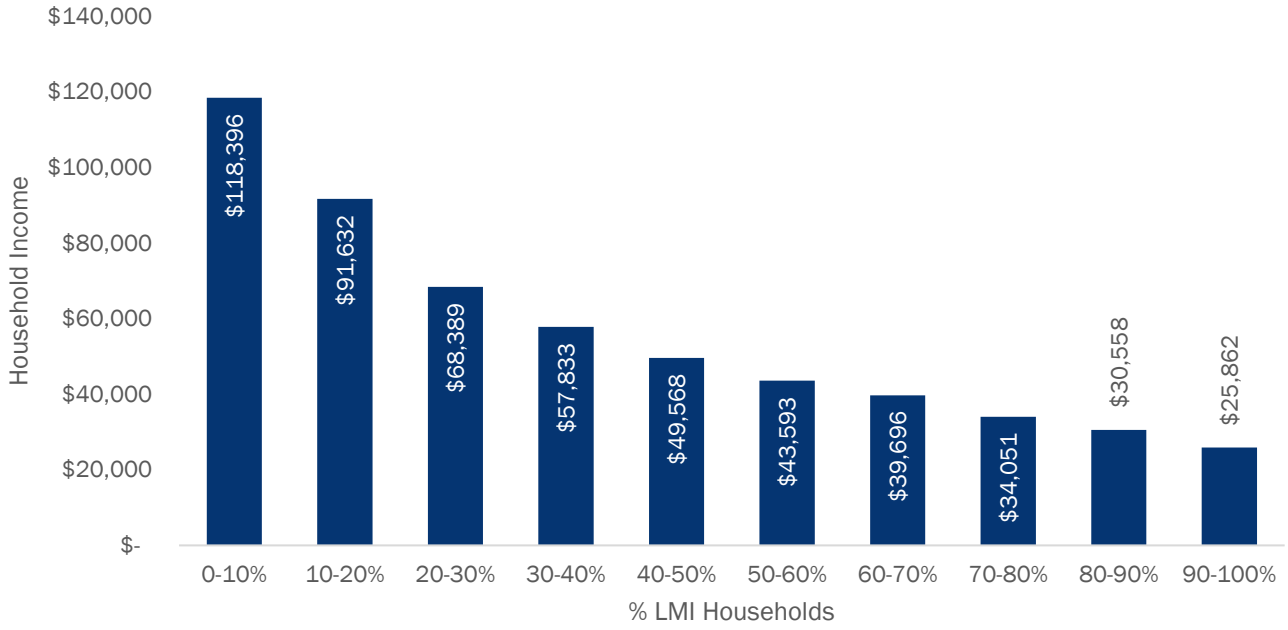
Figure 1. Duke Energy LMI Customer Characteristics



Social and Demographic Characteristics

By definition, the more LMI households in a neighborhood, the lower the median household income. In neighborhoods with 10% or fewer LMI households, we found the median household income was $120,000, compared to about $26,000 in neighborhoods where 90% or more of households met LMI criteria (Figure 2).[4] This has major implications both for the ability of these households to afford their energy bills as well as their ability to invest in energy efficiency upgrades that can lower their energy costs overall.

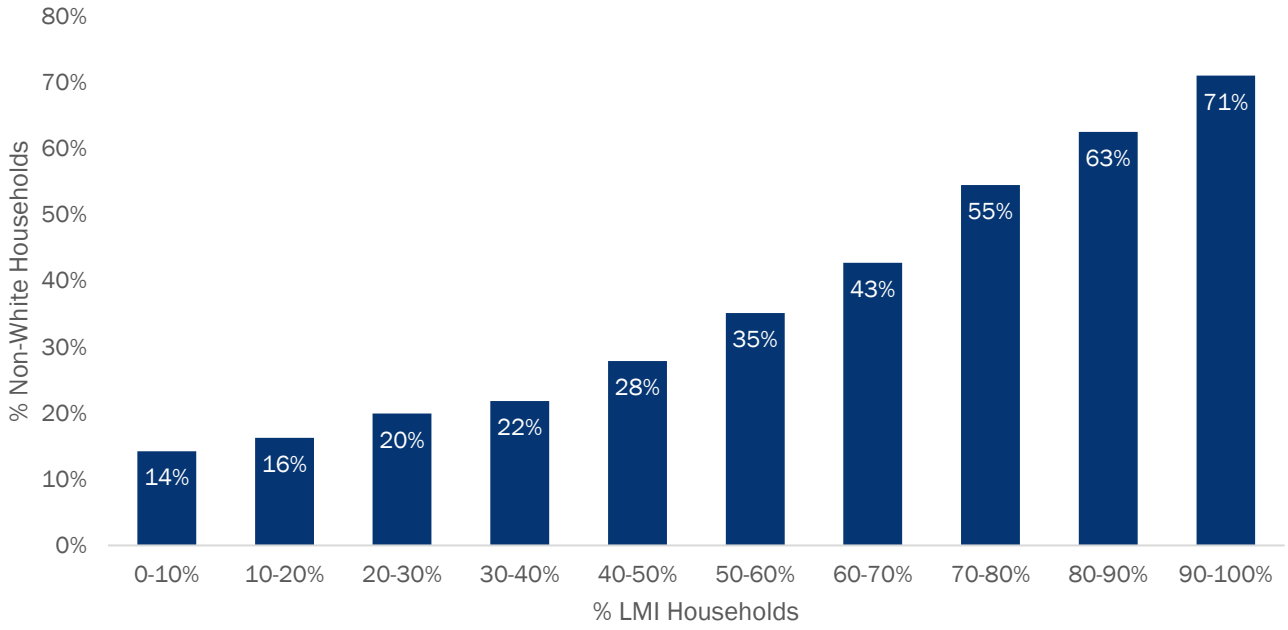
Figure 2. % LMI Households and Median Household Income



The higher the proportion of LMI households in a neighborhood, the greater representation there was from members of disadvantaged groups. Individuals who identify as non-white made up 16% of the population in neighborhoods where 20% or fewer of the households were LMI, but 65% of the population in neighborhoods where 80% or more of households were LMI (Figure 3).

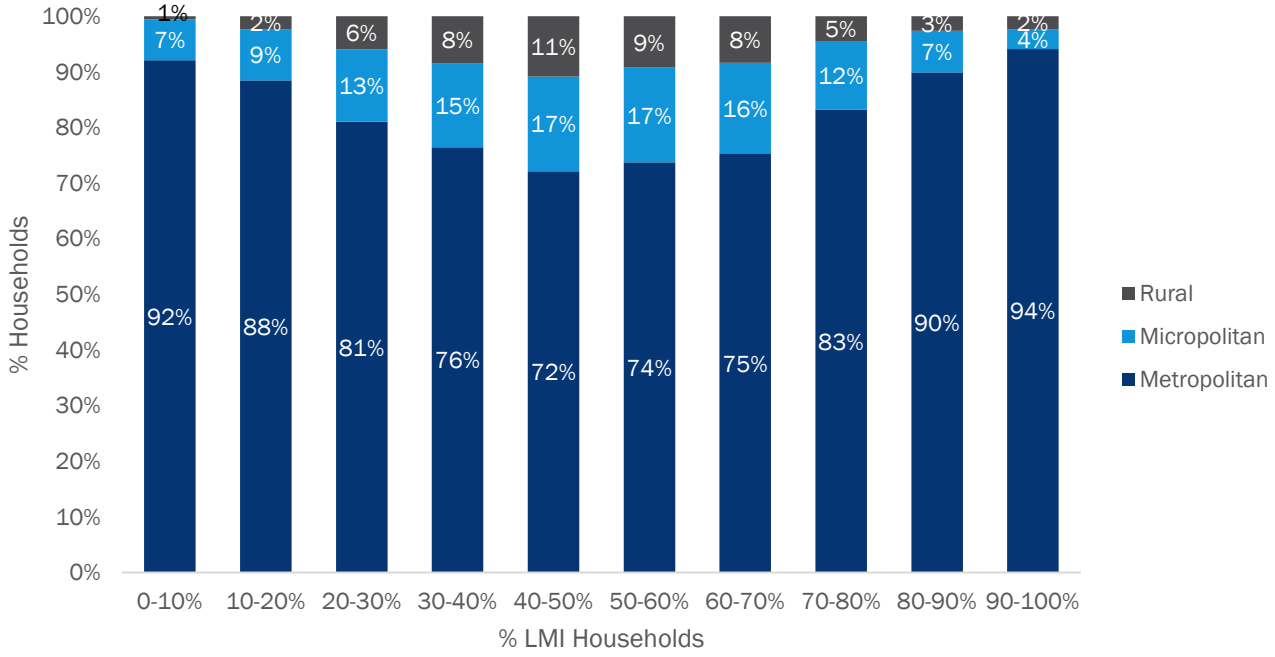
[4] We cannot characterize neighborhoods with a lower percentage of LMI households (50% to 80%) as moderate income neighborhoods. While these neighborhoods have higher median incomes than our LMI neighborhoods, at least half of the households meet this study's definition of LMI, of which some will be low and some moderate income. The remaining households in those neighborhoods exceed the LMI definition. Therefore, we chose to focus most of our analysis and comparisons on low and high LMI neighborhoods.

Figure 3. LMI Households and Percent Non-white Population



Most households in neighborhoods with a high percentage of LMI households fall within a metropolitan statistical area, which the US census defines as having at least one urbanized area with 50,000 or more inhabitants (Figure 4). High LMI neighborhoods have similar population densities to neighborhoods with few LMI households. Compared to low and high LMI neighborhoods, neighborhoods that have a moderate percentage of LMI households (30% to 70%) are more likely to have households in both micropolitan (at least one area with between 10,000 and 50,000 inhabitants) and rural areas.

Figure 4. LMI Households and Population Density



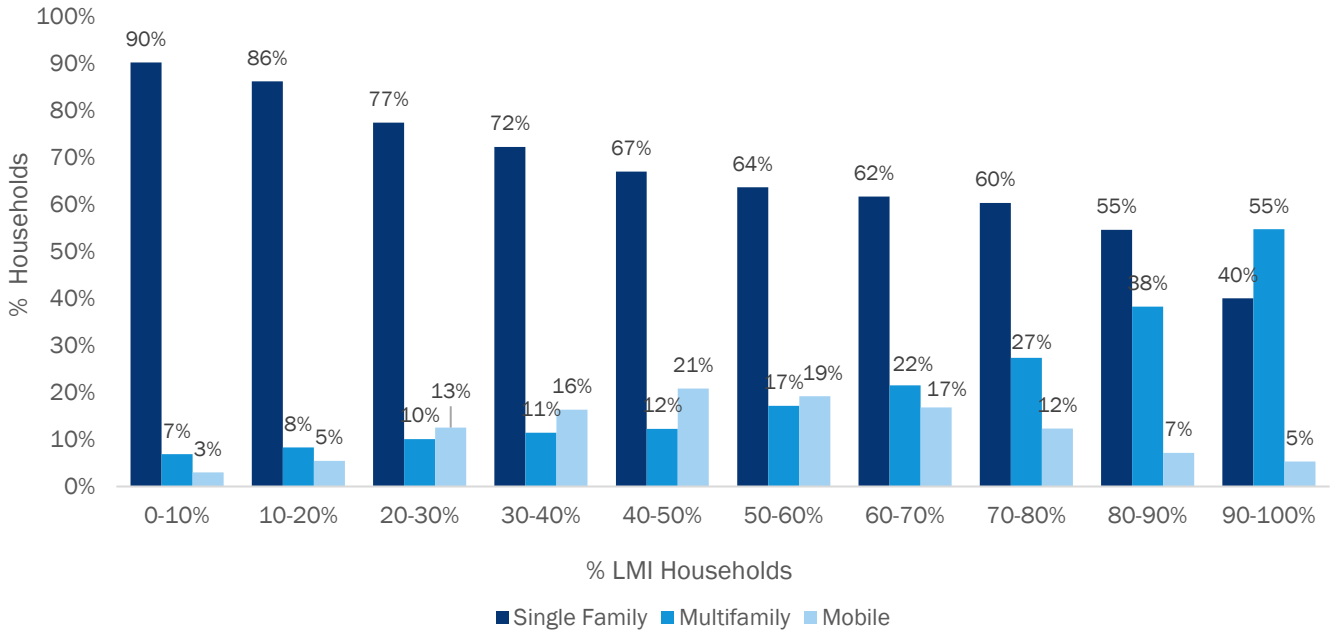
Neighborhoods with a high proportion of LMI households also tended to have a higher share of households that faced barriers to accessing resources such as social services and energy efficiency programs. These barriers included lack of internet access and limited ability to communicate in English. In neighborhoods where only 20% or fewer households were LMI, 7% of households lacked internet access, but in neighborhoods where at least 80% of households were LMI, 28% of households lacked internet access. Similarly, in neighborhoods where 20% of households were LMI, 1% of households had limited ability to communicate in English, compared to 5% of households in neighborhoods with 80% or more households that met LMI criteria.

Housing Characteristics

Neighborhoods with a high proportion of LMI households had very different housing stock and occupant characteristics than neighborhoods with fewer LMI households, suggesting that program eligibility, needs, and interest may vary in important ways between these groups.

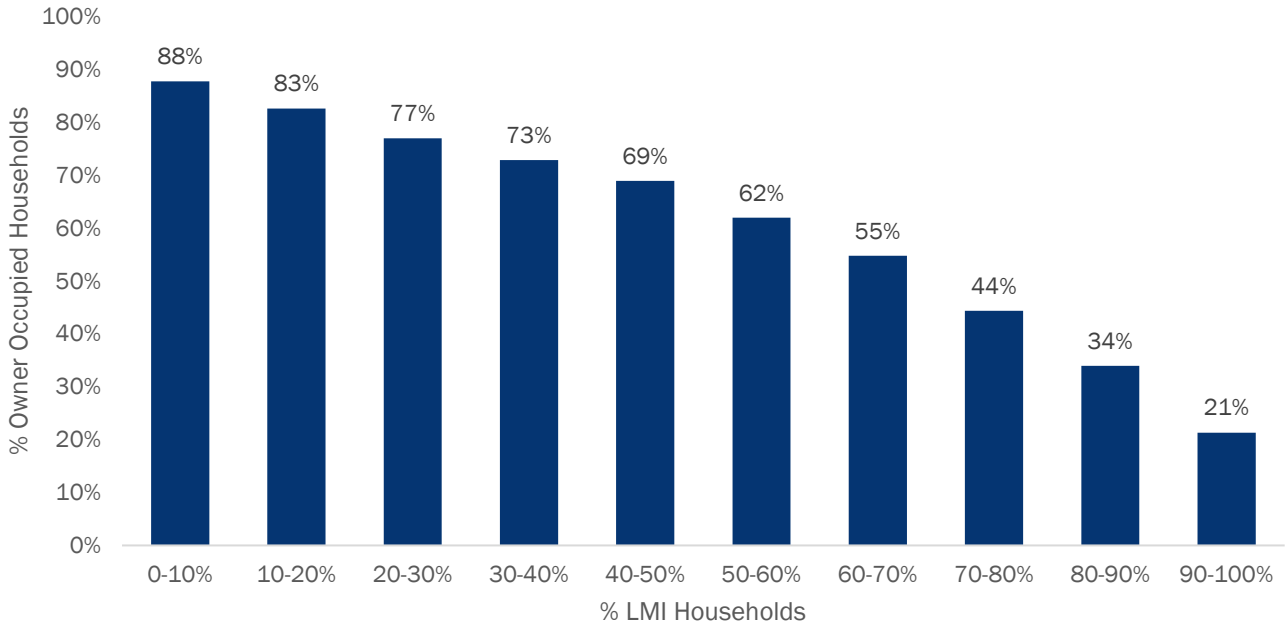
In neighborhoods where 20% or fewer of households were LMI, 87% of homes were single family, compared to 51% of homes in neighborhoods where 80% or more of households were LMI. Neighborhoods with a high proportion of LMI households had a much greater incidence of multifamily homes. Mixed-income neighborhoods had the highest proportion of mobile homes (Figure 5).

Figure 5. LMI Households and Percent Housing Units by Type



In neighborhoods where 20% or fewer of households were LMI, the vast majority (84%) of homes were owner occupied. In contrast, in neighborhoods where 80% or more of households met LMI criteria, only 31% of housing units were owner occupied (Figure 6). The split incentive problem is a well-known challenge for serving customers who rent and pay their own utility bills. Because the landlord does not receive the benefit of bill savings from energy efficiency improvements, there is little incentive to choose more expensive efficient versions of equipment or to make weatherization upgrades. Given the disproportionate representation of LMI households among renters, it will be important to have participation processes that overcome the barriers renters face to maximize support for LMI customers from Duke Energy programs.

Figure 6. LMI Households and Percent Owner Occupied Housing Units



Duke Energy's LMI customers are likely to move more frequently than non-LMI customers. Because customers open a new account whenever they move, the younger average age of Duke Energy accounts among LMI households (4 years vs. 7 years for non-LMI customers), suggests more frequent relocation, which may be associated with underlying factors such as renting rather than owning the home, housing instability, and housing affordability. The more transient nature of Duke Energy's LMI customer base may both increase their need for Duke Energy's services (since they theoretically have a new opportunity to participate in each subsequent home) while also introducing challenges such as split incentives.

Energy Use and Burden

On average, households in LMI neighborhoods within the Duke Energy service territory consumed less energy than households in non-LMI neighborhoods (Table 9). This was likely due to a combination of factors, including smaller housing units, a greater number of multifamily households, and greater efforts to reduce energy consumption among LMI customers to save money on bills.

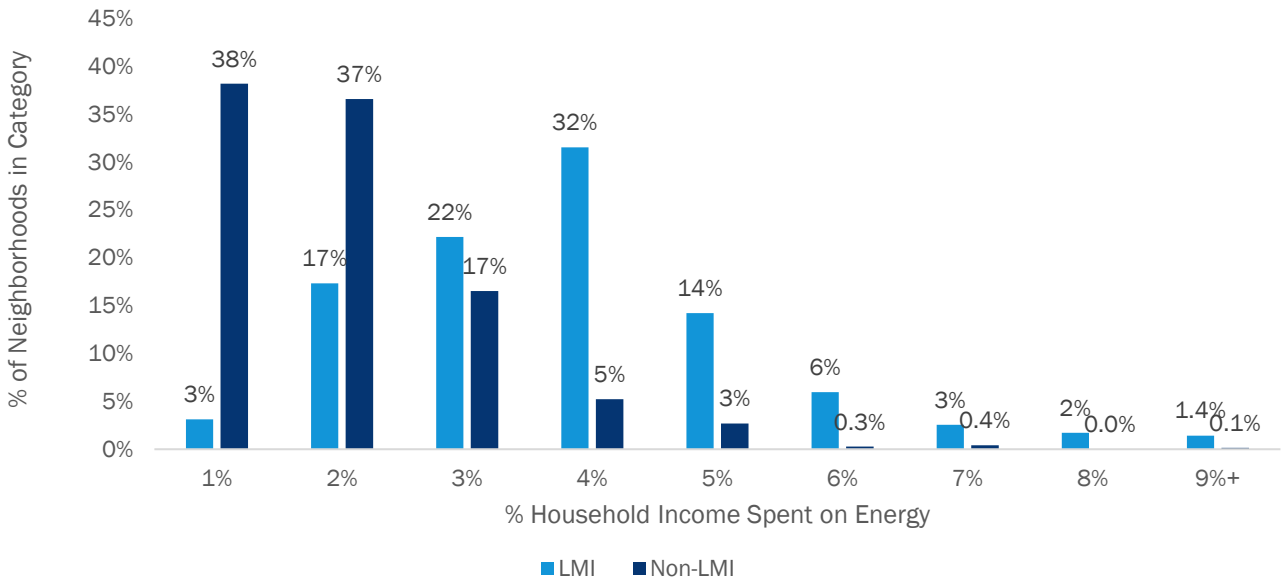
Table 9. Average Daily Consumption by Group

LMI Status of Neighborhood	Average Daily Consumption (kwh)
80% or more LMI	19.5
21 to 79% LMI	24.8
20% or less LMI	29.6

Despite the lower energy consumption observed among households in neighborhoods with a high percentatge of LMI households, Duke Energy's territory, households in LMI neighborhoods had slightly higher energy burdens, on average, than households in non-LMI neighborhoods. Energy burden is a measure of the percentage of household income spent on energy bills. The average energy burden in LMI neighborhoods was

3.8%, compared to 2.0% in non-LMI neighborhoods. More importantly, households located in neighborhoods in which 80% or more are LMI were much more likely to experience moderate to high energy burdens (over 6%) compared to households in neighborhoods fewer than 20% are LMI. In high LMI neighborhoods, it6.4% of households have an average energy burden over 6% compared to 0.5% of low LMI neighborhoods.[5] Figure 7 summarizes energy burdens in LMI and non-LMI neighborhoods.

Figure 7. Energy Burden in LMI and Non-LMI Neighborhoods



The discrepancy between LMI and non-LMI energy burden is likely to be even greater at the individual household level than what can be observed at the neighborhood level. The Home Energy Affordability Gap study found that in North Carolina in 2021, households below 50% of the Federal Poverty Level dedicated, on average, 29% of their annual household income towards home energy bills. Whereas, households between 50% and 100% of the Federal Poverty Level dedicated an average of 16% of their annual household income towards home energy bills.[6] Likewise, in South Carolina, households below 50% of the Federal Poverty Level paid 31% of their annual household income on home energy bills and households between 50% and 100% of the Federal Poverty level paid 16% of their annual household income on home energy bills.[7] This suggests that neighborhood-level data masks household-level variation in energy burden, which is likely to be a very real burden for low-income households, i particular. Data from interviews and surveys with Duke Energy's LMI customers support this hypothesis, with many respondents stating bill affordability is a major challenge and reducing energy costs is a high priority.

[5] A moderate residential energy burden is more than 6% of income and a high residential energy burden is more than 10% of income. APPRISE (Applied Public Policy Research Institute for Study and Evaluation). 2005. *LIHEAP Energy Burden Evaluation Study*. Washington, DC: HHS (Department of Health and Human Services).
https://www.acf.hhs.gov/sites/default/files/documents/ocs/comm_liheap_energyburdenstudy_apprise.pdf
[6] Fisher, Sheehan & Colton. 2022. North Carolina: The Home Energy Affordability Gap 2021.
http://www.homeenergyaffordabilitygap.com/03a_affordabilityData.html
[7] Fisher, Sheehan & Colton. 2022. South Carolina: The Home Energy Affordability Gap 2021.
http://www.homeenergyaffordabilitygap.com/03a_affordabilityData.html

The differences observed between LMI and non-LMI neighborhoods are important for understanding the energy efficiency needs, barriers, motivations, and impacts of Duke Energy's LMI customers.

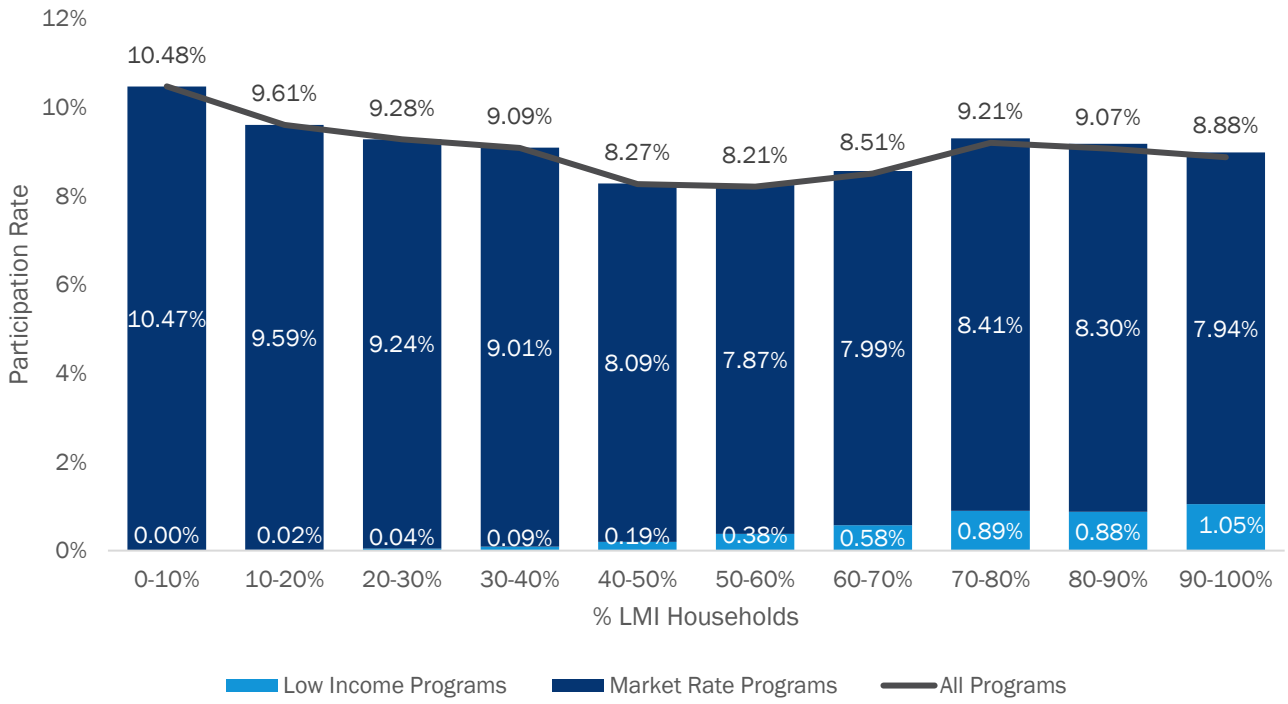
4.2 Program Participation Among LMI Customers

Program Participation Rates

Between 2013 and 2021, average annual participation in Duke Energy programs was slightly lower in neighborhoods that have a moderate to high percentage of LMI households compared to those with few LMI households.[8] Program participation was lowest in neighborhoods that have a moderate percentage of low-income households (Figure 8). In neighborhoods where between 40% to 50% of households are LMI, an average of 8.27% of households participated in Duke Energy programs each year compared to 8.88% in neighborhoods with a high percentage of LMI households (90% or more) and 10.48% of households in neighborhoods with few LMI households (less than 10%).

Both moderate and high LMI neighborhoods have lower participation rates in market rate programs (~ 8%) compared to low LMI neighborhoods (~10%). But in high LMI neighborhoods, a small but meaningful percentage of households (~1%) participate in low income programs, which somewhat makes up for their lower participation in market rate programs. In neighborhoods with a moderate percentage of LMI households, fewer participate in low income programs (less than 0.5%).

Figure 8. LMI Households and Annual Program Participation Rates by Program Type[a]



[8] Annual participation rates were calculated as the number of participating accounts in a given year divided by the number of active accounts in the same year. Participation rates for the entire study period were calculated as participating accounts divided by total accounts active at any point in the study period.

[a] Percentages reflect the percentage of customers who participated in at least one program of each type in a single year. Because customers could participate in both a low income and market rate program in a single year, the percentages for "All Programs" may be less than the sum of the percentage who participated in low income and market rate programs.

DEC had much higher participation in market rate programs than DEP due to the Free LED/CFL program offered by DEC. Comparing just those neighborhoods with a low percentage (less than 20%) and high percentage (80% or more) of LMI households, we found that while overall participation rates were lower in DEC territory than in DEP territory, the percentage point difference in participation rates between households in LMI and non-LMI neighborhoods was similar for both territories. In both DEC and DEP, customers in LMI neighborhoods are slightly less likely to participate in market rate programs and in high savings program offerings compared to customers in non-LMI neighborhoods (Table 10).[9]

Table 10. Participation Rate Summary[a]

Territory	Program Types	LMI	Non-LMI
DEC	**All Programs**	**11.96%**	**12.77%**
	Market Rate	11.12%	12.76%
	Low Income	0.99%	0.02%
	High Savings	3.00%	3.90%
DEP	**All Programs**	**3.56%**	**4.49%**
	Market Rate	2.80%	4.49%
	Low Income	0.79%	0.01%
	High Savings	2.70%	3.30%
Overall	**All Programs**	**9.03%**	**9.83%**
	Market Rate	8.21%	9.81%
	Low Income	0.92%	0.01%
	High Savings	2.90%	3.70%

[a] Percentages reflect the percentage of customers who participated in at least one program of each type in a single year. Because customers could participate in both a low income and market rate program in a single year, the percentages for "All Programs" may be less than the sum of the percentage who participated in low income and market rate programs.

Among households in both LMI and non-LMI neighborhoods, participation rates in Duke Energy programs have fluctuated over time. In the DEC territory, there was a sharp decrease in both LMI and non-LMI participation rates between 2019 and 2021 (Figure 9). In DEP territory, rates have generally increased over time, with a large jump in LMI participation rates between 2015 and 2017 before falling below non-LMI participation rates in subsequent years (Figure 10). It is possible that recent decreases are driven, at least in part, by the COVID-19 pandemic. In the DEC territory, the decrease was also affected by discontinuation of the Free LED/CFL program. In DEC territory, LMI and non-LMI customer participation rates have followed similar trends over time, whereas in DEP territory LMI participation rates tended to diverge from non-LMI rates and to vary more by year than non-LMI rates.

[9] High savings offerings are defined as those participation instances in which the ex ante savings of the household are greater than the mean ex ante savings of all households participating in that year.

Of customers who participated in one or more Duke Energy programs between 2013 and 2021, the vast majority (68%) participated in just one program. This analysis accounts for recurring participation customers who moved and opened a new account under the same customer ID. Households in LMI neighborhoods were less likely to participate in more than one program (21%) compared to households in non-LMI neighborhoods (31%).

Figure 9. DEC Participation Rates Over Time

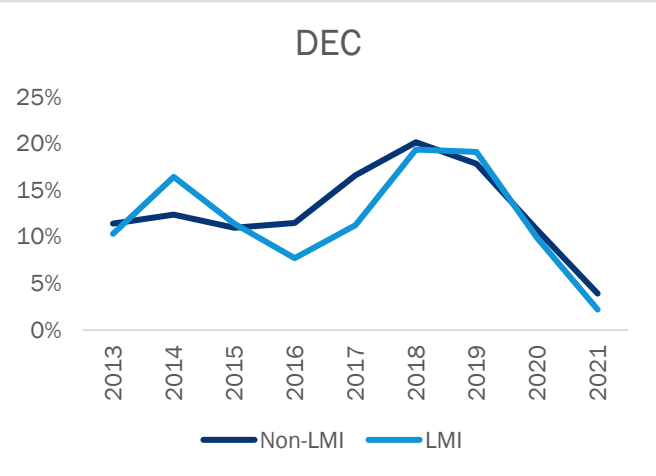
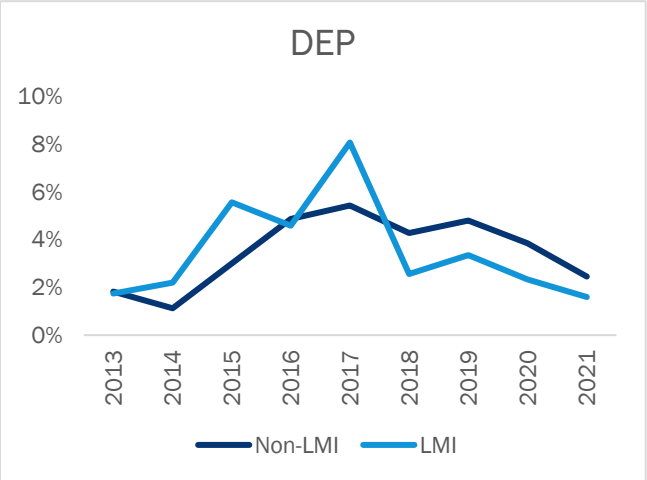
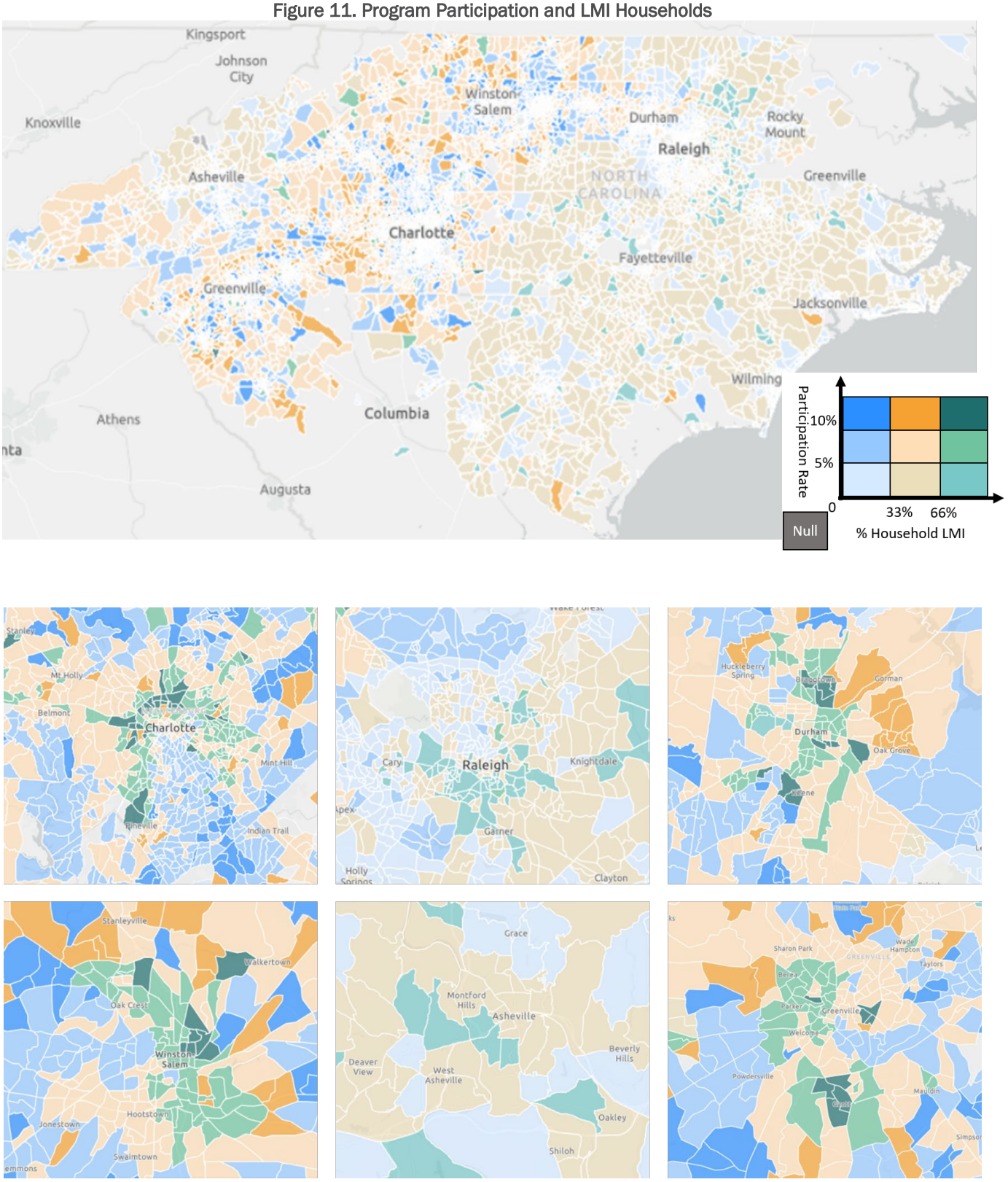


Figure 10. DEP Participation Rates Over Time



Within each jurisdiction, there was geographic variation in program participation rates. Figure 11. Program Participation and LMI Households illustrates the relationship between the proportion of LMI households in each census block group and the participation rate. Green neighborhoods had the highest proportion of LMI customers, while blue neighborhoods had the lowest proportion. Darker shaded neighborhoods within each color had higher participation rates than lighter-shaded neighborhoods. Outside of urban areas, it was rare to observe neighborhoods with a high proportion of LMI households and high rate of participation, while Duke Energy was sometimes reaching a high proportion of LMI households in urban neighborhoods. There were also large swaths of the Carolinas comprised of mixed-income neighborhoods, where about half of households were LMI, with low participation rates.

Figure 11. Program Participation and LMI Households

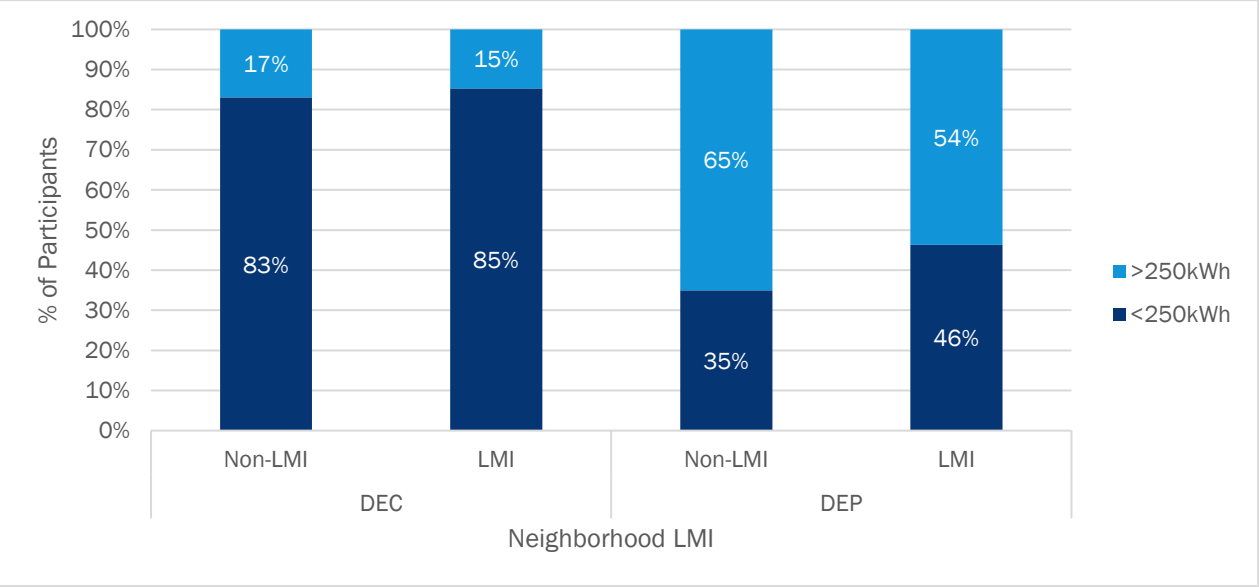


Program Types and Savings Potential

During the study period, customers in LMI neighborhoods participated at slightly lower rates in Duke Energy programs compared to those in non-LMI neighborhoods. Customers in LMI neighborhoods may also participate in different program offerings than those in non-LMI neighborhoods, which may affect their savings potential and the benefits they realize from participation.

To examine whether participation differs by program savings, we grouped programs into two categories: (1) programs with potential savings below 250 kWh and (2) those with savings above 250 kWh.[10] Figure 12 shows the percentage of participants in each program savings level for LMI and non-LMI neighborhoods. We provide results separately for DEP and DEC because of the large number of participants in DEC's free CFL/LED program, which had lower savings compared to many programs. For DEC, because the free lighting program had more participants than any other program, a majority of participants participated in a lower savings program, and there was little difference in participation rates for LMI compared to non-LMI neighborhoods. For DEP, we found that customers from non-LMI neighborhoods were more likely to participate in programs with higher savings potential than customers from LMI neighborhoods. Two-thirds of participants in non-LMI neighborhoods (65%) participated in higher savings programs compared to slightly over half in LMI neighborhoods (54%).

Figure 12. Participation by Program Savings Potential and Neighborhood LMI Composition



To dig deeper into LMI customer participation, we looked at LMI customer participation levels across specific programs. Six percent of Duke Energy customers live in neighborhoods where 80% or more of households are LMI. If a program serves LMI and non-LMI households equally, it should draw 6% of its participants from LMI neighborhoods. Programs with participation rates below 6% indicate that customers from LMI neighborhoods are underrepresented and those above 6% indicate LMI neighborhoods are overrepresented.

[10] For program savings, we used ex ante savings values from program tracking data for each program measure. A program's total savings could be based on multiple measures. Per-household savings vary based on measure mix and changes in ex ante savings projections over time.

DEC's free LED/CFL program drew 6% of its participants from LMI neighborhoods indicating that customers from LMI neighborhoods were as likely to participate as those from non-LMI neighborhoods (Table 11). However, for most programs, less than 6% of participants lived in LMI neighborhoods, suggesting that LMI customers were under-served by these offerings. LMI customer participation is lowest (2%) in those market rate offerings with the highest savings potential: Home Energy House Call/Residential Energy Assessments (average savings of 856 kWh per household) and Home Energy Improvement/Smart$aver HVAC (average savings of 498 kWh per household). These higher savings programs typically require a much greater upfront investment on the part of the customer. Among market rate offerings, LMI customer participation was highest in multifamily programs, where LMI customers comprise 15% of participants. This above-average participation helps to offset lower levels of LMI customer participation in other market rate offerings.

Table 11. Summary of Participation by Program

Program	Total Participants in Study Period [a]	% of Participants from LMI Neighborhoods			Average Ex Ante Savings (kWh) [b]
		DEC	DEP	Overall	
Market Rate Programs					
Appliance Recycling Program	38,800	3%	3%	3%	437
Free LED/CFL Program	1,988,300	6%		6%	23
Home Energy House Call Residential Energy Assessments	120,100	2%	2%	2%	856
Home Energy Improvement Smart$aver HVAC	195,900	1%	2%	2%	498
K12	223,100	5%	4%	4%	256
Multifamily Residential EE Multifamily	257,900	16%	13%	15%	260
Online Savings Store	241,900	2%	2%	2%	136
Residential New Construction	24,600		2%	2%	347
Save Energy in Water Single Family Water Measures	455,100	3%	2%	3%	337
Low-Income Programs [c]					
Low-Income Weatherization	4,100	10%		10%	2,169
Neighborhood Energy Saver	79,600	23%	14%	20%	443
Weatherization Pay per kWh Pilot	300		0.3%	0.3%	968

[a] Participant count rounded to nearest hundred.

[b] Savings based on ex ante values as provided in program tracking data. Value represents average of total per-household savings when savings from all measures are combined. Per-household savings vary based on measure mix and changes in ex ante savings projections over time.

[c] Percentage of customers coming from LMI neighborhoods is less than 100% for low-income offerings due to differences in how low-income status is qualified between the programs and this study, and because moderate-income households do not qualify for these programs but are included in the study.

Low-income programs make up a small but meaningful percentage of participation, particularly in those neighborhoods where Duke Energy has focused efforts to reach low-income customers and can provide an opportunity for low-income households to achieve more substantial savings than typically achieved through market rate programs. For example, the Neighborhood Energy Saver program had the highest rate of LMI customer participation of all programs analyzed (20%), with moderately high per-household savings projections. The Low-Income Weatherization Program achieved the highest per-household savings of all programs included in the study but reached very few customers (Table 11). This underscores the reality that despite the importance of low-income programs to meet the needs of low-income customers, in almost all

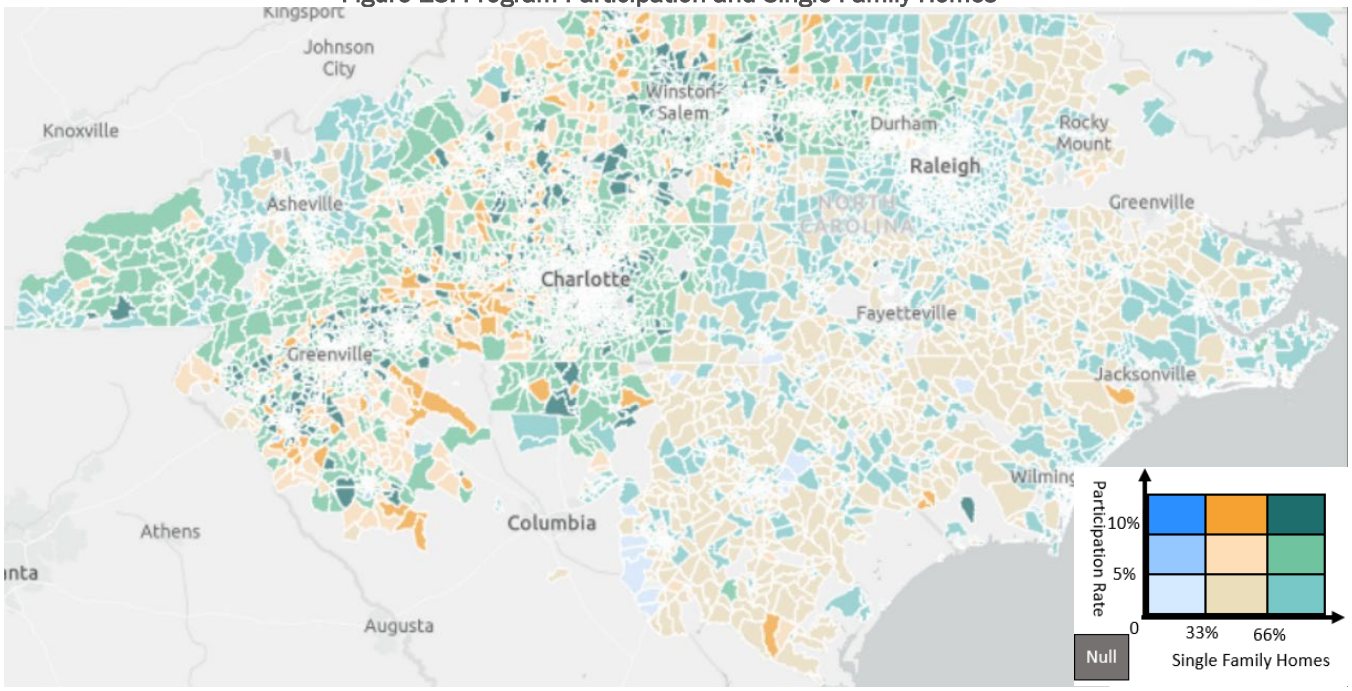
neighborhoods, the vast majority of program participation was driven by market rate programs. In addition, moderate income customers who do not qualify for low-income offerings but still struggle to pay their energy bills would benefit from greater access to market rate offerings.

Relationship Between Participation and LMI Customer Characteristics

While program participation rates do not correspond strongly with LMI status, they do fluctuate based on housing and economic characteristics related to LMI status.

In general, program participation rates were higher in neighborhoods with a greater proportion of single family homes. The average participation rate in neighborhoods where at least 80% of households reside in single family homes was 3.5%, compared to 2.1% in neighborhoods where 20% or fewer households reside in single family homes. As discussed previously, LMI customers were less likely to reside in single family homes compared to non-LMI customers. Figure 13 shows the relationship between home type and program participation across the Duke Energy territory in the Carolinas. Neighborhoods with a moderate to high proportion of single family homes were more likely to have high participation rates, whereas neighborhoods with few single family homes rarely had high participation rates.

Figure 13. Program Participation and Single Family Homes [a]



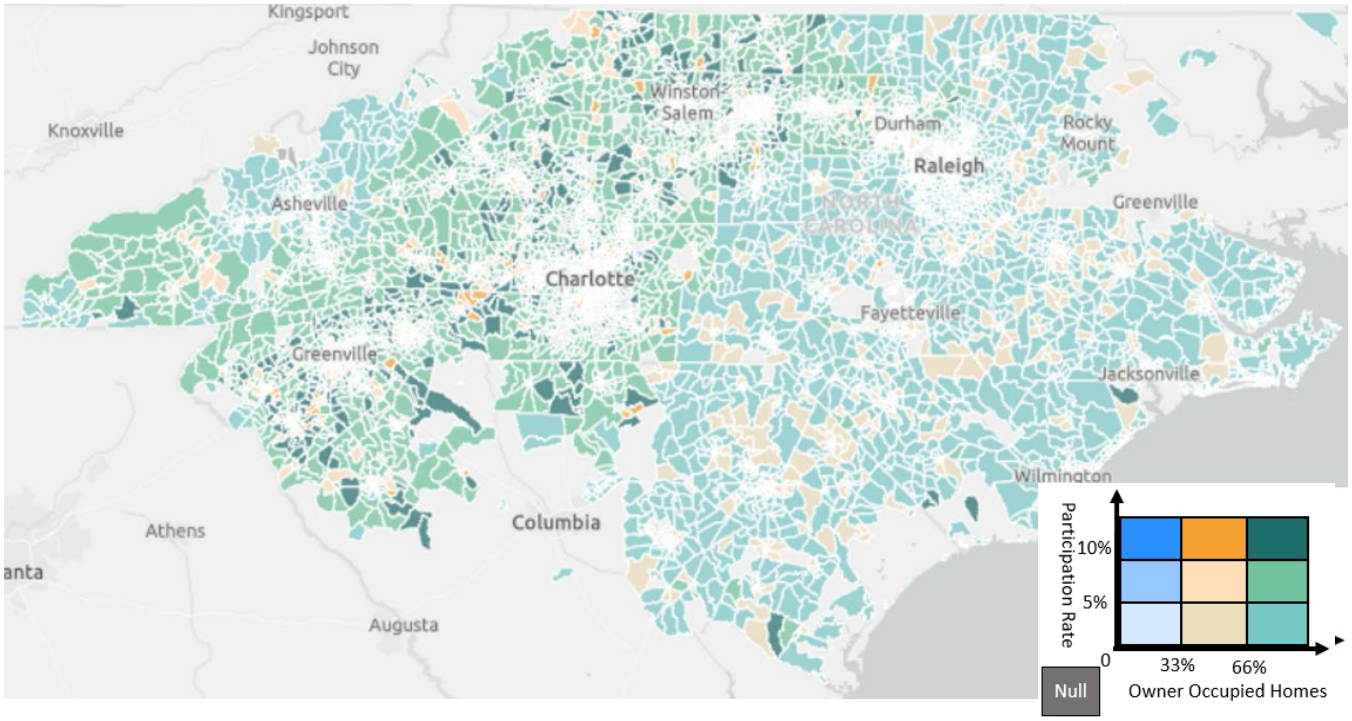
[a] Detailed maps showing participation rates in urban areas are available in Appendix A.

Program participation rates were also higher in neighborhoods with a greater proportion of owner-occupied homes.[11] The average participation rate in neighborhoods where at least 80% of customers own their homes was 3.5%, compared to 2.4% in neighborhoods where 20% or fewer households own their homes. This is important because LMI customers were less likely to own their home compared to non-LMI customers. Neighborhoods with a high proportion of single family homes were much more likely to achieve moderate to high participation rates, whereas when home ownership dipped to even moderate levels, neighborhoods were

[11] These characteristics are correlated. Homeowners are more likely to live in single family homes, while renters are more likely to reside in multifamily homes.

unlikely to reach high participation levels (Figure 14). There were some notable exceptions in the urban cores of Charlotte, Durham, and Winston-Salem, which Duke Energy may wish to explore in order to better understand how these pockets of success could be replicated and expanded.[12]

Figure 14. Program Participation and Owner Occupied Units [a]

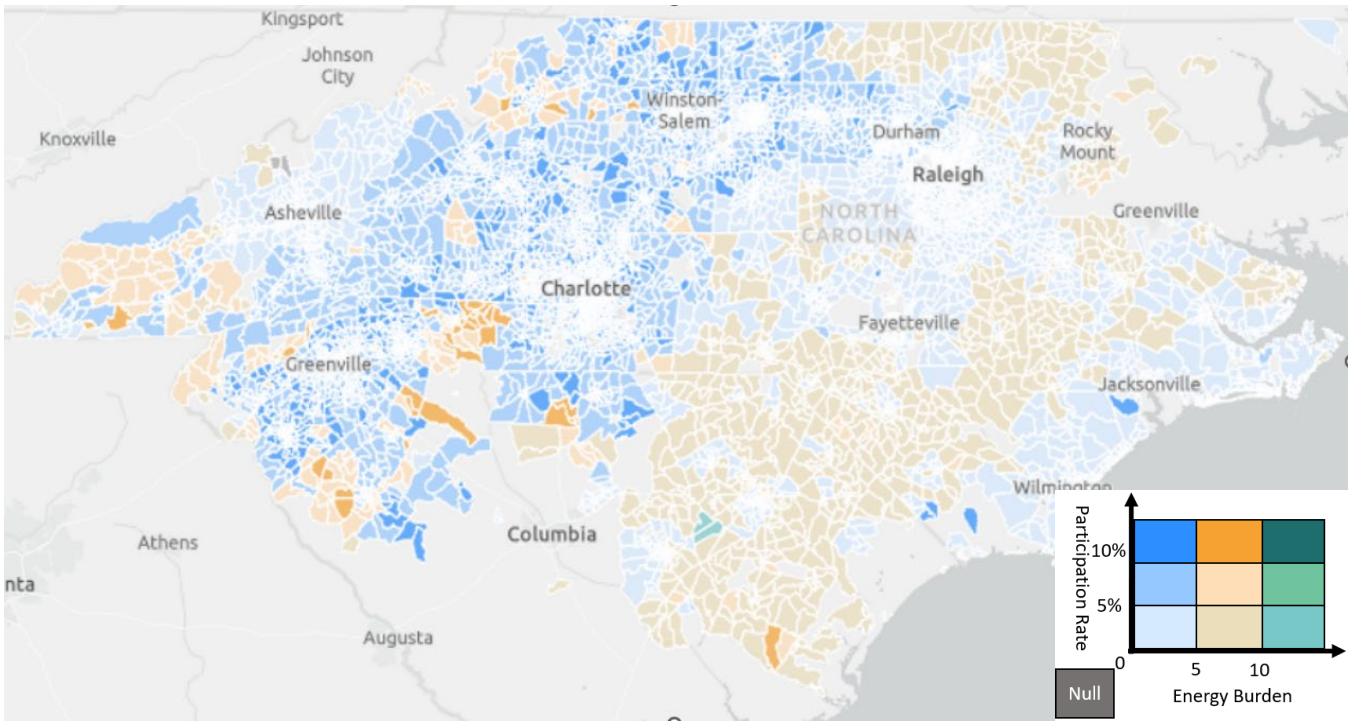


[a] Detailed maps showing participation rates in urban areas are available in Appendix A.

Program participation rates were generally lower in those neighborhoods where customers faced the highest energy burdens. The average participation rate in neighborhoods with an average energy burden of more than 6% was 2.6% compared to 3.1% in neighborhoods with an average energy burden of 6% or less. Most neighborhoods with a moderate energy burden had low participation rates, whereas neighborhoods with low energy burdens often achieved moderate to high participation rates (Figure 15). This matters because LMI customers had a higher average energy burden than non-LMI customers, although this effect is somewhat muted in the neighborhood-level data.

[12] Appendix A includes maps of the urban areas noted here.

Figure 15. Program Participation and Energy Burden [a]



[a] Detailed maps showing participation rates in urban areas are available in Appendix A.

4.3 Drivers of and Barriers to Participation Among LMI Customers

Our descriptive analysis showed that while program participation rates did not vary substantially between LMI and non-LMI households, LMI customers were different from non-LMI customers in important ways. These differences in demographic, housing, and economic characteristics result in unique barriers and motivations to program participation. We explored these barriers through both statistical analysis and primary research with Duke Energy customers, both of which are presented in this section.

Neighborhood Level Findings: Participation Model

To understand the impact of LMI status on Duke Energy program participation rates, we fit a linear regression model using census and participation data that assessed the relationship between a variety of housing, sociodemographic, and energy consumption characteristics at the neighborhood level and Duke Energy program participation rates.

There are three key insights that emerged from this analysis:

- Housing and sociodemographic characteristics are stronger predictors of program participation than is LMI status alone.
- Different factors predict participation in high savings offerings than in low savings offerings.
- There is variation within neighborhoods. Neighborhood-level analysis is likely to obscure household-level differences that would more strongly predict participation in Duke Energy programs.

We explore each of these findings in more depth below. We provide more detail on data cleaning and model specifications in Appendix B.

Importance of LMI Status vs. Other Characteristics

As we documented earlier, compared to non-LMI households, LMI households are more likely to face barriers to participation in Duke Energy programs such as renting their homes or lacking internet access. To assess the relative impact of different barriers to participation and whether there are some additional unmeasured factors associated with being an LMI household that could impact participation, we tested models that included LMI status only, sociodemographic and housing characteristics only, and models including predictors from both categories. We found that the models with the best explanatory power were those that included only the sociodemographic and housing characteristics and excluded LMI status. Model results suggests the underlying characteristics associated with LMI status, and not the fact of being an LMI household, most impacted the decision to participate in a Duke Energy program. Because LMI households faced these barriers at higher rates than other households, they likely faced barriers to accessing energy efficiency programs that non-LMI households did not. To successfully engage LMI households, it is important to address underlying differences that correlate with LMI status, rather than LMI status alone, as these differences are what drive and prevent program engagement.

Drivers of Participation in High vs. Low Savings Offerings

We ran separate models for low and high savings programs to determine if there were different drivers and barriers to participation by savings level. Like the model we ran predicting participation across all programs, we found no independent impact from LMI status in models that also included sociodemographic and housing characteristics for either low or high savings programs.

We found different factors contributed to the decision to participate in low and high savings programs (Table 12). Our analysis showed neighborhoods that were urban, had more single family homes, more homes with electric heating fuel, and higher average household energy consumption had higher participation rates in high savings offerings. Neighborhoods with lower average household energy consumption were more likely to participate in programs with low potential savings. Our analysis also showed some unexpected results.

We found that neighborhoods with a higher proportion of non-white residents were more likely to access high savings opportunities, potentially as a result of a higher concentration of non-white customers in urban areas, where participation rates also tended to be higher. Similarly, neighborhoods with a higher proportion of households without internet access participated at a higher rate in high savings opportunities. The reason for this is less clear, but these findings could be driven by Duke Energy outreach in neighborhoods with poor internet access.

The factors that correspond with participation rates in low savings offerings were less clear, suggesting that Duke Energy is reaching a more diverse customer base with these offerings. For example, the analysis shows that neighborhoods in both cities and towns, and with a high proportion of white or non-white residents, were likely to have high participation rates in these offerings. Neighborhoods with high average energy consumption, high rates of electric heating fuel, and high energy burden were less likely to participate in low savings opportunities.

Table 12. Participation Model Results

Characteristic	High Savings Model Statistic	Low Savings Model Statistic
High Proportion Homeowners	0.324	0.770
High Proportion Renters	0.051	-0.135
Neighborhood is in City	0.621*	2.820*
Neighborhood is in Town	0.358*	2.638*
High Proportion Non-White Residents	0.682*	0.876*
High Proportion White Residents	-0.016	1.168*
High Proportion Single Family Housing [a]	0.463*	-0.107
Low Average Household Energy Consumption	-0.915*	0.709*
High Average Household Energy Consumption	0.459*	-0.960*
Very High Proportion Electric Heating Fuel	0.426*	-2.180*
High Proportion Electric Heating Fuel	0.117*	-0.500*
High Average Energy Burden	0.197*	-2.546*
High Proportion Households without Internet Access	0.475*	0.022

*Statistically significant at 90% confidence level

[a] Defined as homes with five units or fewer

The drivers of participation in high-savings programs are associated with LMI status in important ways that may affect the likelihood of LMI households to engage with high savings offerings from Duke Energy. In Table 13, we summarize the different characteristics that are associated with participation, whether LMI neighborhoods have higher or lower rates of each characteristic, and the combined overall impact of each on LMI participation. The color coding reflects the overall impact with light blue indicating characteristics that are associated with increased LMI participation and purple indicating lower participation. We find that the strong correlation between single family housing and high energy consumption and participation in Duke Energy programs may translate to lower participation rates for LMI households because LMI households are much less likely to live in single family homes and have higher consumption levels. Neighborhoods with a greater share of households that are non-white or lack internet access (characteristics that are more common in LMI neighborhoods) also participate at higher rates. This result runs counter to our expectations. It is possible that once we control for characteristics like housing type or urban/rural in the model, neighborhoods with higher rates of non-white households or that lack internet access participate at greater rates than expected.

Table 13. Relationship Between High-Savings Predictors and LMI Status

Characteristic	Impact on Participation	Relationship with LMI	Overall Impact on LMI Participation
Neighborhood is in City	Positive	None	Neutral
High Proportion Non-White Residents	Positive	Much more likely	Positive
High Proportion Households Without Internet Access	Positive	Much more likely	Positive
High Proportion Electric Heating Fuel	Positive	Somewhat more likely	Positive
High Proportion Single Family Housing	Positive	Much less likely	Negative
High Average Household Energy Consumption	Positive	Much less likely	Negative

Variation Within Neighborhoods

The overall explanatory power of the models used in this analysis is low, explaining only 16% of the variation in program participation rates between census block groups. It is likely that household-level variation within neighborhoods (i.e., differences between LMI and non-LMI households, and between LMI households with different circumstances) limits the explanatory power of data once aggregated to the neighborhood level. The next section further explores the experience of LMI customers using household-level data collected through primary research.

Household-Level Findings: Customer Survey

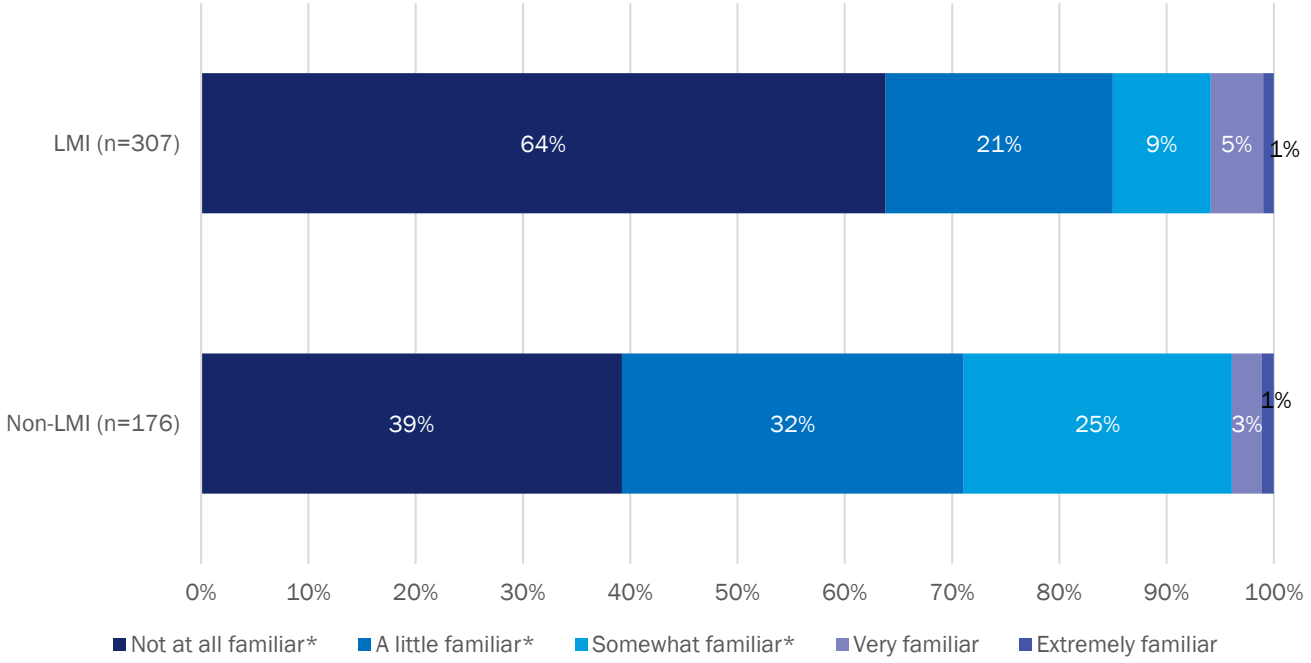
As part of our multi-level analysis, we also conducted research with participating and nonparticipating Duke Energy customers to understand their individual experiences, their motivators for and barriers to participation, and how they preferred to learn about energy efficiency offerings. This research builds on findings from the statistical model and provides additional nuance that can help Duke Energy to reach more of their customers with the greatest needs.

Awareness, Knowledge, and Control

Among LMI nonparticipants, awareness and knowledge of Duke Energy programs was low, as was knowledge and autonomy over home energy consumption, creating up front barriers to program participation among this population.[13] Two-thirds (64%) of LMI nonparticipants said they were not at all familiar with Duke Energy programs that help customers save energy in their homes, compared to 39% of non-LMI nonparticipants (Figure 16).

[13] 25% of nonparticipants (n=483) and 32% of participants (n=362) did not report their income and have been excluded from the results reported in this section.

Figure 16. Nonparticipant Familiarity with Duke Energy Programs

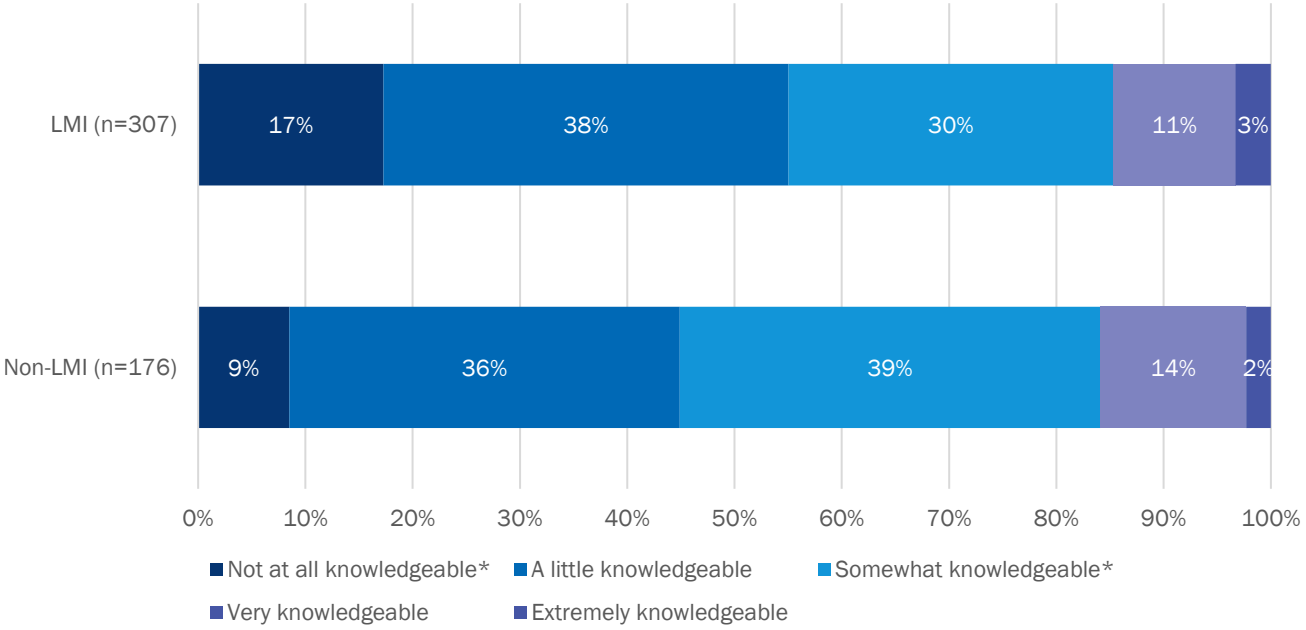


* Statistically significant difference between groups at a 90% confidence level

Of nonparticipants that were aware of Duke Energy's energy efficiency offerings, non-LMI nonparticipants were more likely to have considered participating in the past than LMI nonparticipants (43% vs. 36%, respectively). Non-LMI nonparticipants who considered participating were also more likely than their LMI counterparts to have taken any steps to begin participating such as visiting the Duke Energy website to learn more about energy efficiency programs or calling to inquire about the participation process (6% vs. 3%, respectively).

Nonparticipants had low awareness of energy efficiency opportunities in general, with LMI customers reporting even lower awareness than non-LMI customers. Over half of LMI nonparticipants (55%) said they were either not at all knowledgeable or had only a little knowledge about ways to save energy in their homes compared to 45% of non-LMI nonparticipants (Figure 17). These results suggest there is a need for education on home energy saving opportunities for all nonparticipants but especially for LMI customers.

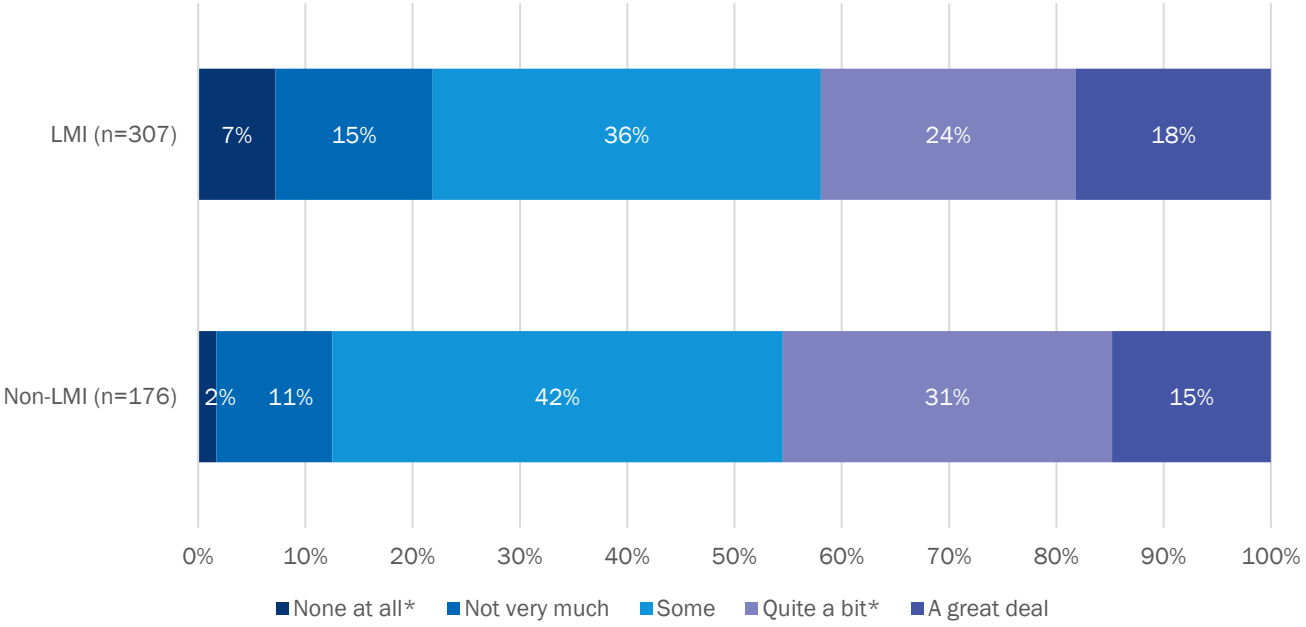
Figure 17. Nonparticipant Knowledge about Saving Energy in the Home



* Statistically significant difference between groups at a 90% confidence level

This lack of knowledge translates to low autonomy among LMI nonparticipants when it comes to reducing their energy consumption. About one in five (22%) LMI nonparticipants felt they have little or not very much control over energy consumption, compared to 13% of non-LMI nonparticipants (Figure 18). This perceived lack of control could be a barrier to entry that prevents LMI nonparticipants from taking the initial steps required to learn about program offerings and eligibility.

Figure 18. Nonparticipant Sense of Control Over Household Energy Use



* Statistically significant difference between groups at a 90% confidence level

Energy Efficiency Improvement Needs

In addition to their lower energy efficiency awareness and knowledge, LMI nonparticipants had greater energy efficiency needs than non-LMI nonparticipants. There were more opportunities for efficiency upgrades in LMI nonparticipants' homes and a need for a greater number of improvements on average compared to non-LMI nonparticipants. About one-third of LMI nonparticipants (33%) said "a lot of things" in their home could be made more energy efficient, compared to only 16% of non-LMI nonparticipants. LMI nonparticipants reported the need for 3.9 improvements on average, compared to 3.3 for non-LMI nonparticipants, when given the opportunity to indicate up to five specific improvements in their home. Specifically, LMI nonparticipants were significantly more likely than non-LMI nonparticipants to say the efficiency of their home could be improved by replacing their CFL light bulbs with LEDs, upgrading the HVAC system(s), and installing and/or replacing windows (Table 14).

Table 14. Nonparticipant Energy Efficiency Improvement Needs

Improvement†	LMI (n=265)	Non-LMI (n=149)
Replace CFL Light Bulbs with LEDs*	55%	37%
Add Air Sealing to the Windows and/or Doors	53%	51%
Upgrade the Heating and/or Cooling System(s)*	43%	34%
Upgrade Appliances (Other than Heating/Cooling Systems) to More Efficient Options	41%	37%
Install Timers or Smart Power Strips to Turn Off Lights and Appliances When Not in Use	40%	36%
Install a Smart or Programmable Thermostat	39%	40%
Install or Replace Windows*	38%	28%

Improvement†	LMI (n=265)	Non-LMI (n=149)
Add Insulation to the Walls and/or Ceilings	31%	27%
Add Faucet Aerators and/or Low-Flow Showerheads to Sinks/Showers	24%	19%
Insulate the Pipes and/or Water Heater	22%	18%
Other Change(s)*	1%	4%

Note: Results based on nonparticipant web survey data – nonparticipants who indicated that there were at least "a few" changes that could be made to make their home more energy efficient

* Statistically significant difference between groups at a 90% confidence level

† Values will not sum to 100% as multiple responses were permitted

To understand if Duke Energy was including all relevant measures in its programs, we asked participants, who are most informed about current offerings, to suggest additional offerings Duke Energy could provide to support them. About one-fifth of participants indicated they would like to see more financial assistance across offerings, indicating that even among participants, up-front cost of improvements can be a barrier. LMI participants were more interested in additional lighting-based offerings than non-LMI participants. Non-LMI participants expressed more interest than LMI participants in higher cost offerings such as those related to solar and battery power, water heating, and electric vehicles (Table 15).

Table 15. Participant Additional Program Offerings Suggested

Additional Offerings†	LMI (n=79)	Non-LMI (n=80)
Measures		
Building Shell/Envelope	14%	9%
Lighting*	13%	4%
Solar/Battery*	11%	30%
HVAC	4%	6%
Plumbing	4%	0%
Thermostat	3%	3%
Water Heating*	1%	10%
EV*	1%	6%
Other	29%	19%
Program Enhancements		
Financial Assistance	18%	16%
More Information	8%	6%

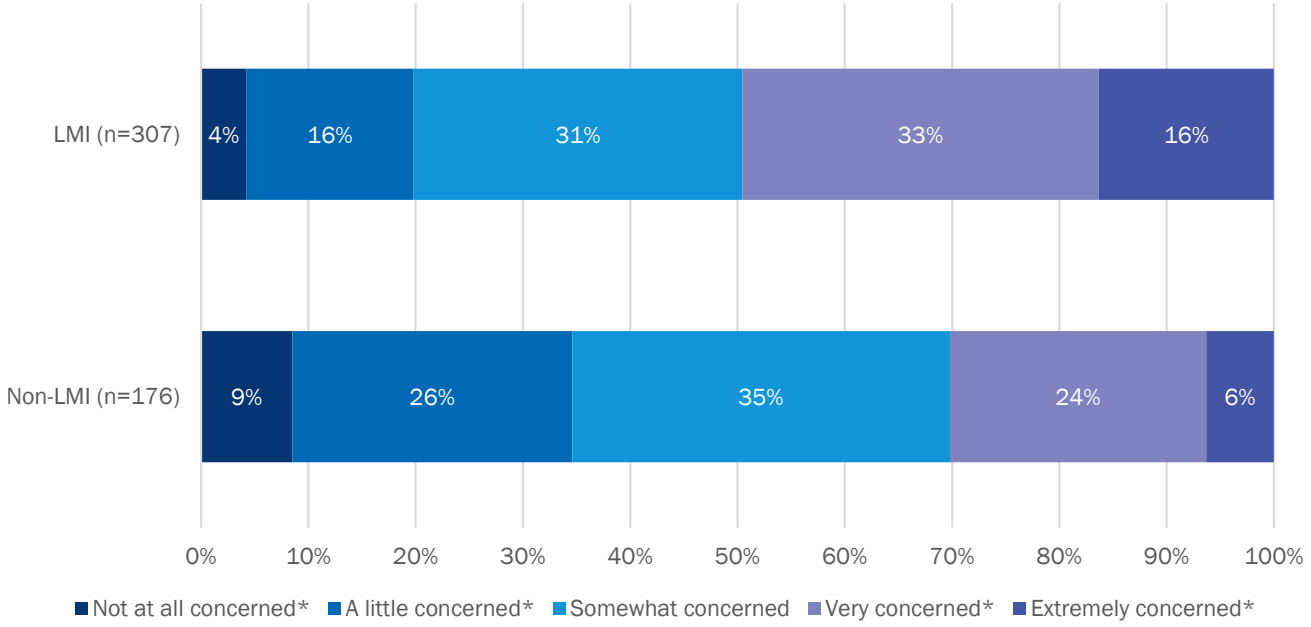
* Statistically significant difference between groups at a 90% confidence level

† Values will not sum to 100% as multiple responses were permitted

Energy Efficiency Motivations

LMI nonparticipants reported being very motivated to reduce their energy consumption by improving the energy efficiency of their homes. LMI nonparticipants were more concerned about their energy usage than non-LMI nonparticipants. Half of LMI nonparticipants (49%) were either "very" or "extremely concerned" about their household energy use, compared to slightly under one-third (30%) of non-LMI nonparticipants (Figure 19). Non-LMI customers were also more likely to be "not at all concerned" about their daily energy usage than LMI customers.

Figure 19. Nonparticipant Concern Over Daily Household Energy Use



* Statistically significant difference between groups at a 90% confidence level

LMI and non-LMI nonparticipants similarly cited saving money as a motivator to use less energy. Non-LMI customers were more likely than LMI customers to say that not being wasteful and reducing their impact on the environment motivates them to save energy (Table 16). These results suggest that, in contrast to LMI customers whose main reason for saving energy is saving money, non-LMI customers are more likely to also consider the non-financial, intangible benefits of saving energy. This has implications for messaging most likely to motivate LMI customers and further suggests that focusing messaging on bill savings is likely to motivate LMI customers without deterring non-LMI customers from participating.

Table 16. Nonparticipant Overall Motivations for Saving Energy

Motivation†	LMI (n=307)	Non-LMI (n=176)
Saving Money	86%	85%
Not Being Wasteful*	42%	53%
I Want to Be Responsible and Thoughtful about My Energy Usage	40%	47%
Reducing my Impact on the Environment*	37%	53%
It is Important that Others See Me as Environmentally Conscious	8%	7%

Note: Results based on nonparticipant web survey data

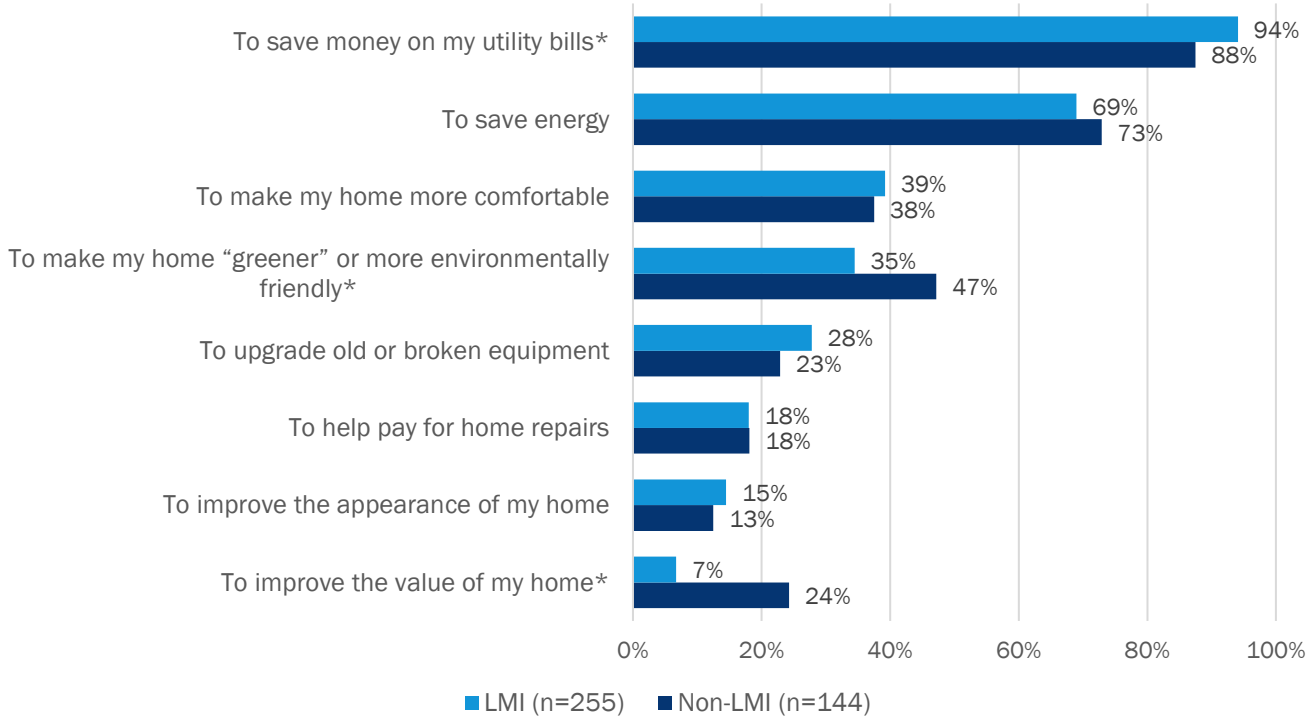
* Statistically significant difference between groups at a 90% confidence level

† Values will not sum to 100% as multiple responses were permitted

When asked specifically about their motivations for participating in a Duke Energy program, nonparticipants were most motivated to participate in the future by the potential utility bill savings (Figure 18). LMI nonparticipants were significantly more interested in participating to save money on utility bills than non-LMI nonparticipants, though large majorities of each group indicated they were motivated by the financial benefits of participation. Non-LMI nonparticipants were significantly more likely than LMI nonparticipants to be

interested in participating to "be green" or improve the value of their home. They were also more likely than LMI nonparticipants to indicate that "being greener" was their biggest motivation to participate. This again suggests the idea that, although all nonparticipants (and all customers in general) are highly motivated to participate in Duke programs by the potential bill savings, LMI nonparticipants are most motivated by the financial benefits associated with participating, while non-LMI nonparticipants tend to have more varied motivations.[14]

Figure 20. Nonparticipant Motivations for Participating in Duke Program Offerings in the Future†



Note: Results based on nonparticipant web survey data – nonparticipants at least "a little likely" to participate in at least one offering in the next two years

* Statistically significant difference between groups at a 90% confidence level

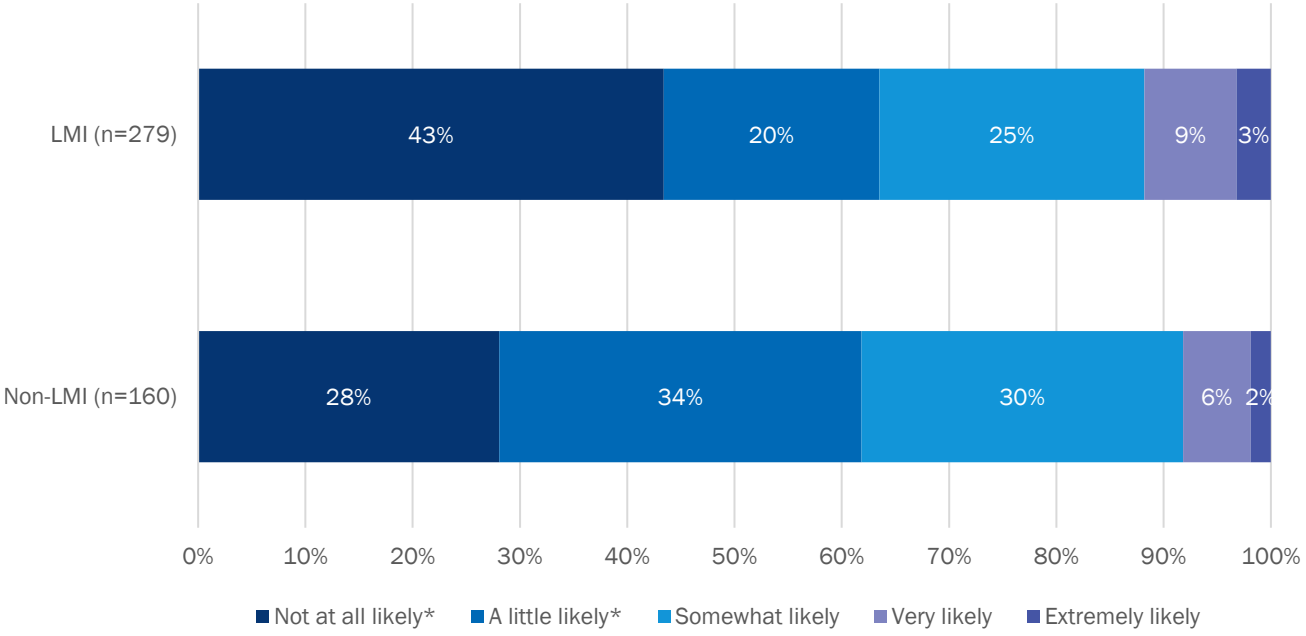
† Values will not sum to 100% as multiple responses were permitted

Likelihood of Future Improvements, Behavior Change, and Participation

Despite LMI nonparticipants indicating that many aspects of their home could be made more efficient and that they are highly concerned about their energy usage and its financial implications, 63% of LMI nonparticipants say that they are "not at all" or only "a little" likely to make changes to their home to make it more efficient in the next year (Figure 21). This suggests that, despite their need, concern, and interest, LMI nonparticipants face considerable barriers to making improvements.

[14] Participants' motivations for participating were highly similar to nonparticipants' motivations. The exceptions are that in addition to the same significant differences seen between the nonparticipant groups, between participant groups, LMI participants were more likely to say they were motivated by saving money on home repairs than their non-LMI counterparts and non-LMI participants were significantly more likely to say they were motivated by saving energy than their LMI counterparts.

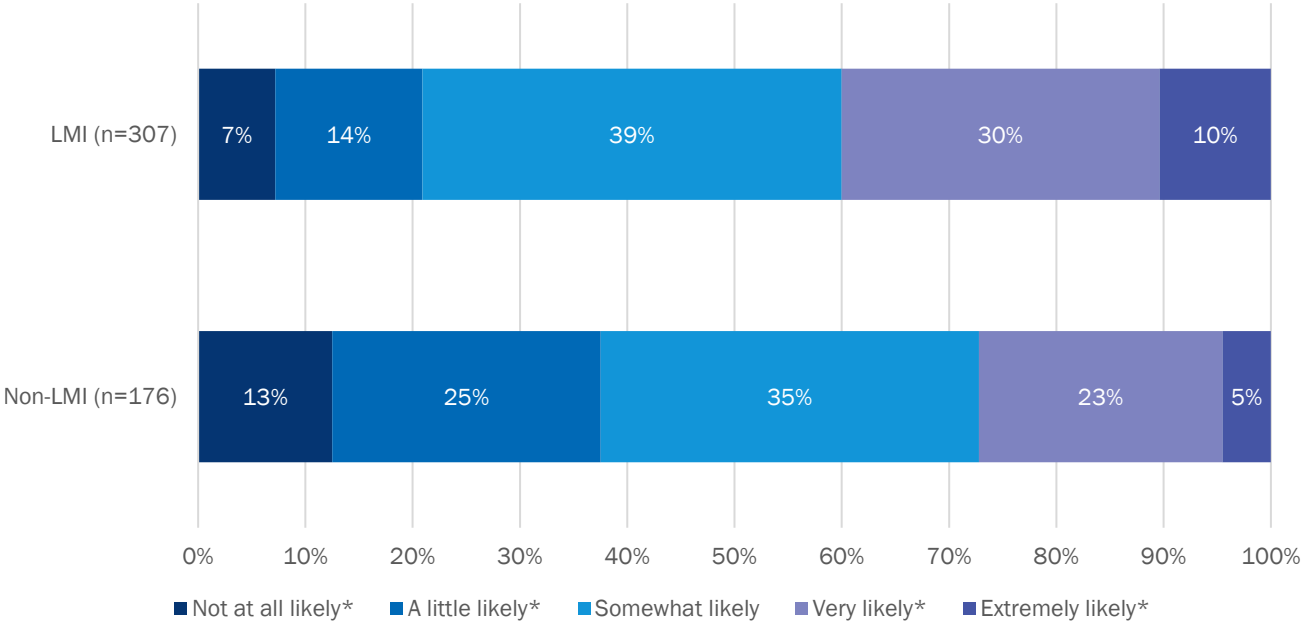
Figure 21. Nonparticipant Likelihood to Make Home More Efficient in Next Year



* Statistically significant difference between groups at a 90% confidence level

Although LMI nonparticipants said they were less likely to make changes to their home to make it efficient than their non-LMI counterparts, that is not reflective of their willingness to make behavioral changes in the next six months to reduce their energy usage. In fact, LMI nonparticipants were significantly more likely than non-LMI nonparticipants to say they are "very" or "extremely likely" to make behavioral changes to reduce their usage (Figure 22). Perhaps because behavioral changes have no financial cost, and for renters, are changes they can control as opposed to their landlords, LMI nonparticipants perceived fewer barriers to making behavioral changes than they did to making structural changes to their homes.

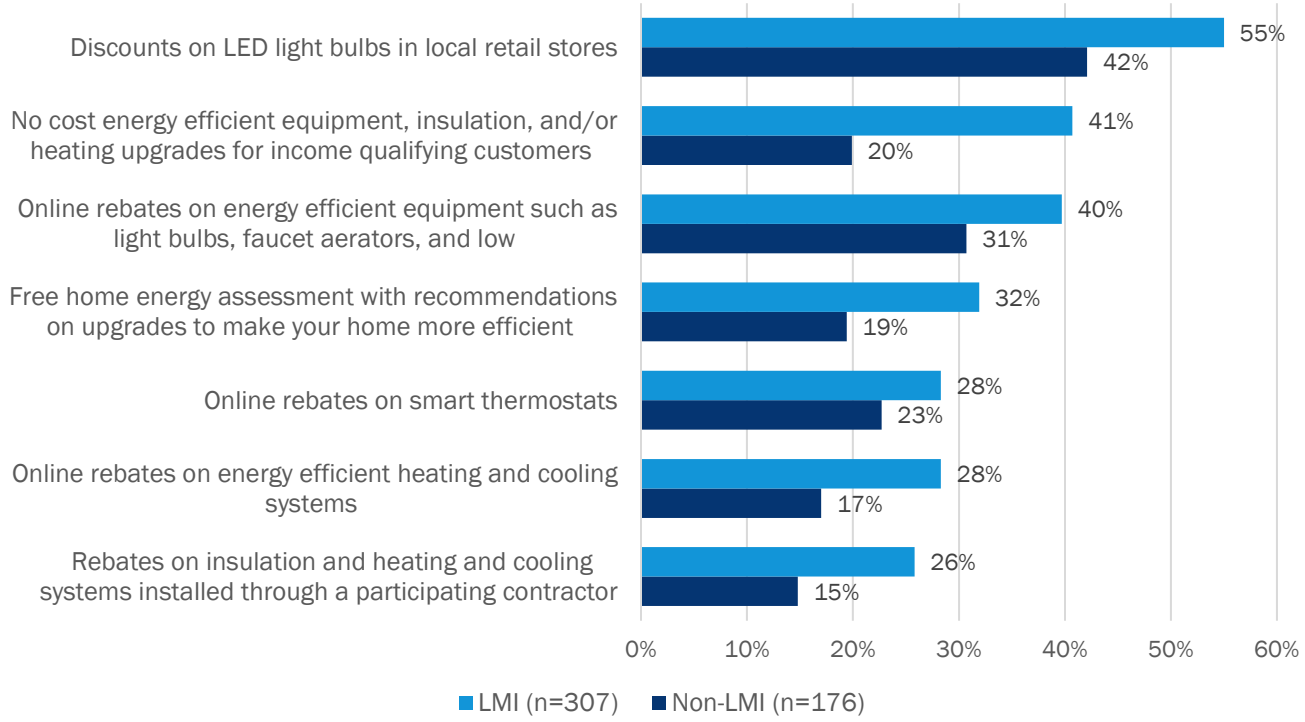
Figure 22. Nonparticipant Likelihood to Make Behavioral Changes in Energy Usage in the Next Six Months



* Statistically significant difference between groups at a 90% confidence level

Similarly, when presented with specific offerings from Duke Energy, LMI nonparticipants were more likely than non-LMI nonparticipants to say they were "very" or "extremely" likely to participate in any type of Duke Energy program in the next two years (Figure 23). LMI nonparticipants were most interested in discounted LED light bulbs in local retail stores (55%), followed by no-cost energy-efficient equipment/insulation/heating upgrades (41%), and online rebates on energy-efficient equipment (40%). They expressed less interest in higher cost and higher savings opportunities such as heating and cooling system rebates (28%) and insulation or heating cooling systems installed through a contractor (26%), despite high proportions of LMI customers indicating that their home would benefit from such upgrades. This suggests that, with the support of a program that addresses their barriers to structural upgrades, LMI nonparticipants are highly likely to make energy efficiency improvements in the next two years. However, barriers such as split incentives and limited financial resources may inhibit LMI customers from seeing high-savings programs as a realistic possibility for their household.

Figure 23. Likelihood of Nonparticipants to Participate in Offerings in Next Two Years†



† Values will not sum to 100% as multiple responses were permitted

Addressing Barriers

Given that LMI customers reported much lower awareness of Duke Energy's programs than non-LMI customers, this section starts by exploring the best ways to reach LMI customers through education and outreach. We then turn our attention to the remaining barriers that must be addressed to maximize meaningful participation among those customers with the greatest need.

Awareness and Education

Regardless of participation history or LMI status, customers who were aware of Duke Energy programs were most likely to have heard of them from a bill insert, a letter or postcard in the mail, or a website (Table 17). This suggests that further outreach should continue to focus primarily on these types of marketing. Although there were not substantive differences in the most common sources of awareness based on LMI status, LMI participants were significantly more likely than non-LMI participants to say they heard about program(s) via an advertisement on the television, a nonprofit agency or other community group, or a video advertisement on streamed online services. Given this finding, there may be potential to reach a greater number of LMI customers with targeted outreach through these channels.

Table 17. Participant and Nonparticipant Sources of Program Awareness

Source †	Participant		Nonparticipant	
	LMI (n=199)	Non-LMI (n=145)	LMI (n=119)	Non-LMI (n=112)
From a Bill Insert*	50%	48%	45%	59%
From a Letter in the Mail or Postcard*	35%	41%	26%	52%
From a Website	31%	38%	40%	33%
From Friends or Family	15%	12%	12%	13%
From an Advertisement on Television§	10%	4%	10%	13%
From a Nonprofit Agency or other community group§	9%	1%	3%	1%
From a Video Advertisement on a Streamed Online Service (e.g., YouTube, Hulu)§*	7%	1%	5%	1%
Email§*[a]	5%	17%	5%	14%
From Local Events (e.g., a Festival or Community Fair or Parade	3%	2%	1%	1%
From Advertisements on the Radio	3%	1%	3%	0%
From Articles in the Newspaper	2%	3%	3%	5%
From an Outdoor Display (e.g., a Billboard or a Bus Shelter)	2%	1%	1%	1%
Other	3%	6%	3%	5%

§ Statistically significant difference between participant groups at a 90% confidence level

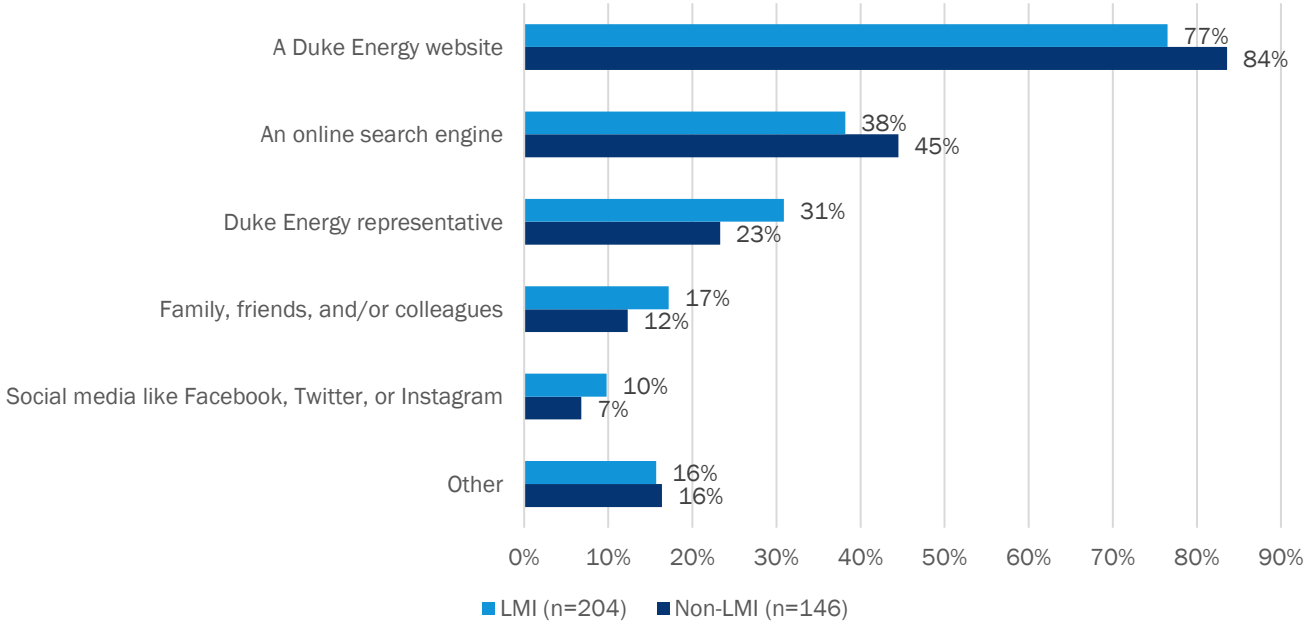
* Statistically significant difference between nonparticipant groups at a 90% confidence level

† Values will not sum to 100% as multiple responses were permitted

[a] Email was not provided as a multiple response option in the survey but was written in by respondents frequently enough to be coded as a separate category during analysis. It is possible more respondents would have selected this option if provided.

When searching for information about energy saving opportunities, both LMI and non-LMI participants indicated their preferred sources were the Duke Energy website, an online search, or a Duke Energy representative (Figure 24). Though there are some moderate differences in the sources participants use to learn more about energy saving opportunities by LMI status, these differences were not statistically significant due to the smaller sample sizes.

Figure 24. Participant Information Gathering Tendencies†

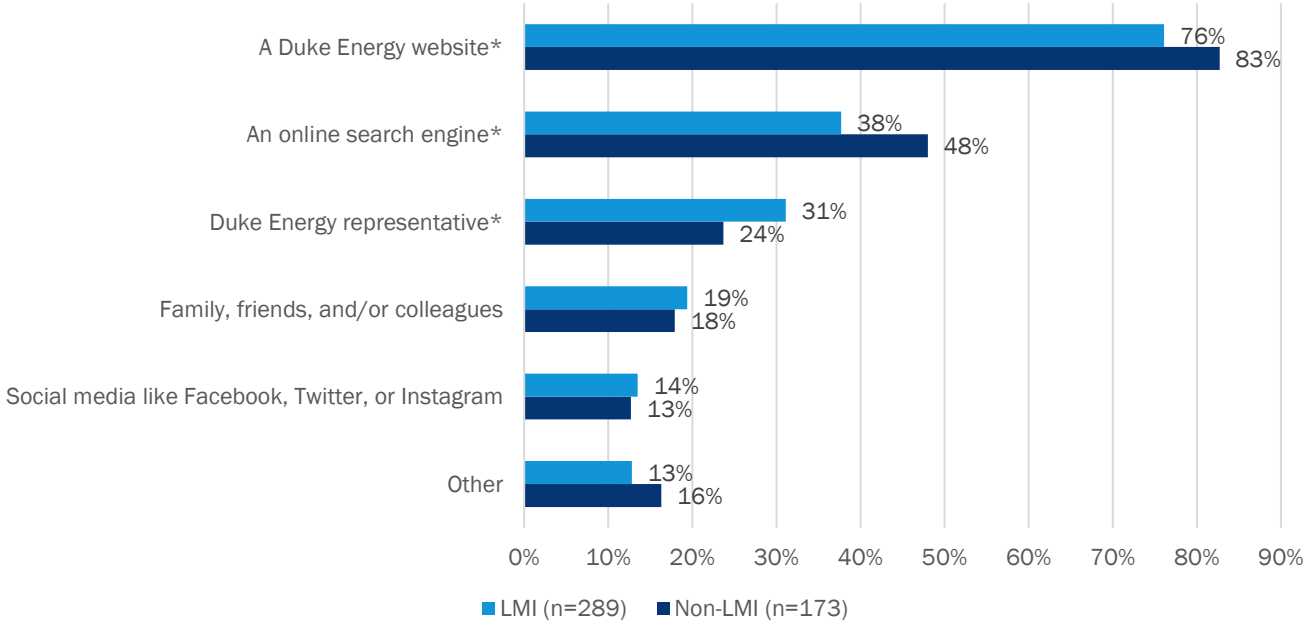


† Values will not sum to 100% as multiple responses were permitted

Although the most common place all participants say they would search for information on energy saving opportunities is a Duke Energy website, only 31% of LMI participants and 38% of non-LMI participants say they actually learned about the program via Duke's website (Table 17). It is possible that customers were only likely to reference the website if they were already highly motivated to save energy, aware of Duke Energy's offerings on at least a general level and were proactively trying to find ways to improve the efficiency of their home. This is a unique type of customer, and their preferences and actions are unlikely to translate to the nonparticipants that Duke Energy is trying to reach.

Like participants, LMI and non-LMI nonparticipants' top sources of information when they are looking for ways to save energy are the Duke Energy website, an online search, and a Duke Energy representative (Figure 25). LMI and non-LMI nonparticipants significantly differed on their preference for several potential sources of information. Notably, LMI nonparticipants were significantly more likely than non-LMI nonparticipants to say they would look for information on energy saving opportunities from a Duke Energy representative.

Figure 25. Nonparticipant Information Gathering Tendencies†



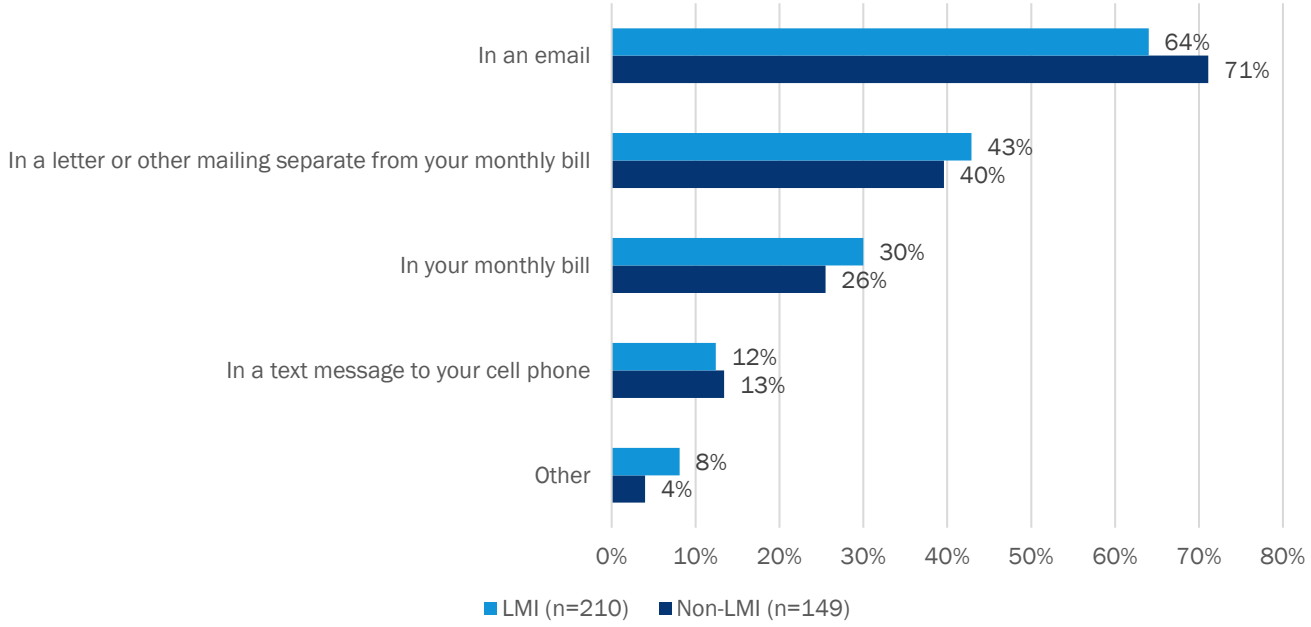
* Statistically significant difference between groups at a 90% confidence level

† Values will not sum to 100% as multiple responses were permitted

Given that the preferred information sources reported among nonparticipants were customer-initiated (i.e., conducting an internet search or visiting Duke Energy's website) and awareness was low among this group, Duke Energy may need to conduct proactive outreach regarding energy saving opportunities. By raising overall program awareness within LMI communities, word-of-mouth outreach from family, friends, and colleagues may become more common over time. Duke may also be able to encourage satisfied LMI participants to refer others in their network who would benefit from program participation. We discuss the high levels of satisfaction among LMI participants in Appendix D

When it comes to the mode of outreach that Duke Energy can leverage for these efforts, both LMI and non-LMI participants indicated they would prefer to receive information from Duke Energy about how to save energy in their home via email, followed by letters or separate mailings, bill inserts, and text messages (Figure 26). Participants' outreach preferences do not meaningfully vary by LMI status, although non-LMI participants are slightly more likely than LMI participants to prefer email outreach, which may reflect differences in age or internet access between these groups.

Figure 26. Participant Outreach Preferences†

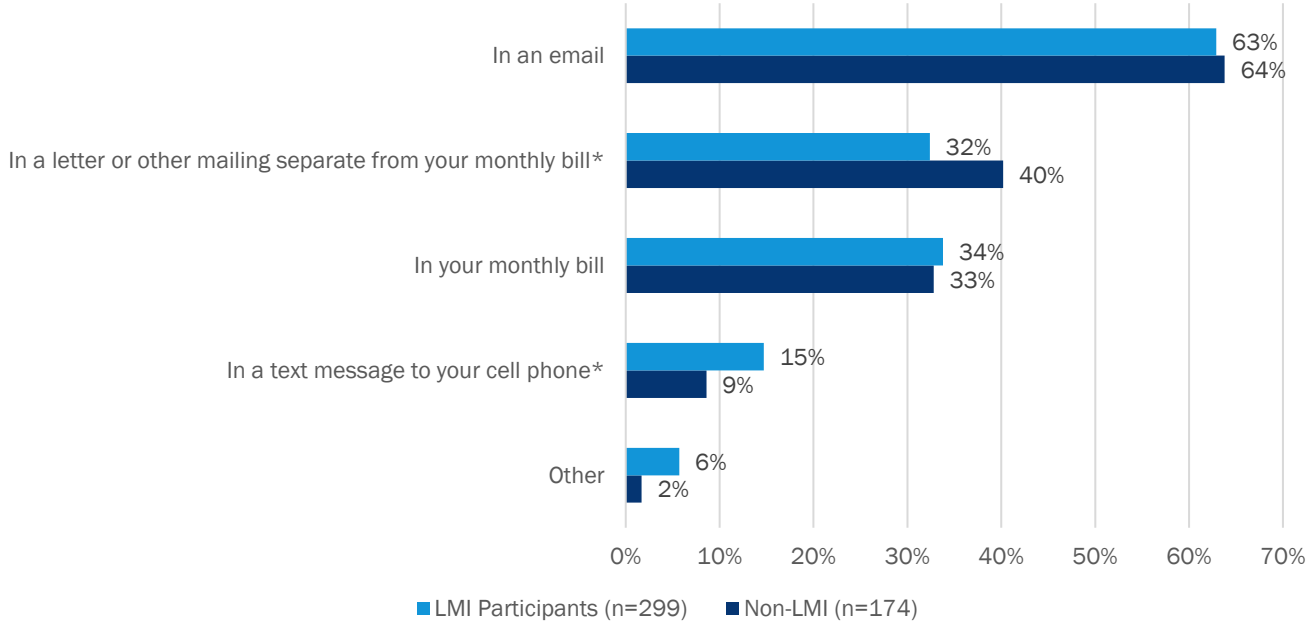


† Values will not sum to 100% as multiple responses were permitted

Like participants, both LMI and non-LMI nonparticipants indicated they would prefer to receive information from Duke Energy about how to save energy in their home via email, followed by letters or separate mailings, bill inserts, and text messages (Figure 27).[15] LMI nonparticipants were slightly more likely to prefer text message outreach compared to non-LMI nonparticipants.

[15] It is important to note that, although email is the most preferred form of outreach for both participants and nonparticipants regardless of LMI status, it is not a highly reported source of program awareness for any group (Table 17). This is at least partially due to the response options given for the associated questions. Specifically, email was not listed as a response option for how customers became aware of Duke's offerings but was entered as an open-ended "other" response with enough frequency that we coded it as a separate category during analysis. It is possible that a larger number of survey respondents would have indicated they heard about the offerings via email if it was a response option, as they would have been forced to consider/recall if they had received any email outreach. In contrast, email was a listed response option when respondents were asked about their overall outreach preferences. As such, although email is not reported commonly as a source of program awareness, it is a key channel for reaching all customers.

Figure 27. Nonparticipant Outreach Preferences†



* Statistically significant difference between groups at a 90% confidence level

† Values will not sum to 100% as multiple responses were permitted

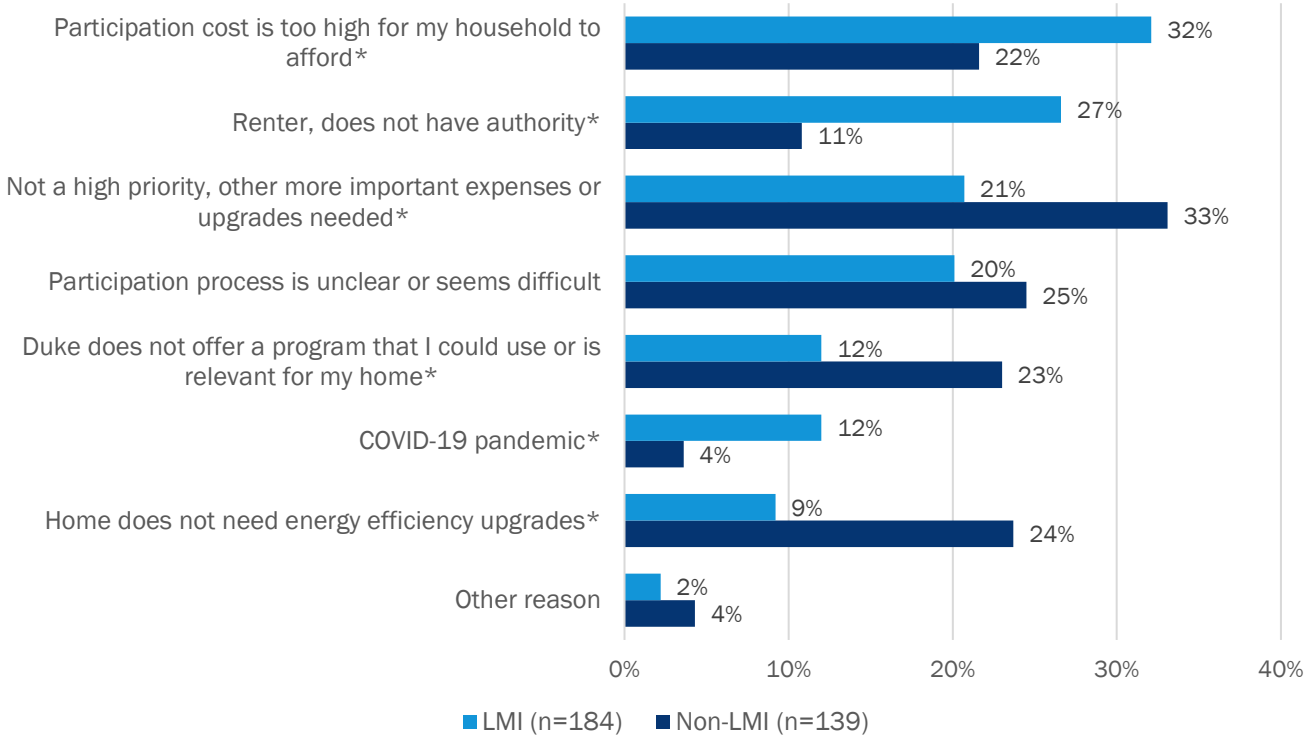
Overall, these results suggest customers' preferred methods for outreach do not vary based on LMI or participation status in a meaningful way, and that email, mailings, and bill inserts are the most preferred methods of outreach across all customers.

Ability and Decision to Participate

Given LMI nonparticipants' high need for and interest in energy efficiency program participation, this section covers the additional barriers that Duke Energy can address to support their participation once initial barriers around knowledge and awareness have been addressed.

LMI and non-LMI nonparticipants responses differed significantly on several barriers to program participation. LMI nonparticipants were more likely than non-LMI nonparticipants to say that the cost of participation, their lack of authority as a renter, and the COVID-19 pandemic were barriers to their participation (Figure 28). Non-LMI nonparticipants were more likely than LMI nonparticipants to cite that participation was not a priority compared to other household expenses and upgrades, that there were no program offerings relevant to them, and that their home did not need any energy efficiency upgrades. Notably, lack of authority due to being a renter was not presented as an option for this question but was noted so frequently in the "other" category that it became the second most prevalent barrier reported by LMI nonparticipants.

Figure 28. Nonparticipant Participation Barriers†



Note: Results based on nonparticipant web survey data – Nonparticipants that considered participating in the past

* Statistically significant difference between groups at a 90% confidence level

† Values will not sum to 100% as multiple responses were permitted

These survey findings were reinforced by participants interviewed as part of the study. Even successful participants faced obstacles in the participation process due to up-front costs and split incentives. Some interviewed participants who rent their homes explained that they were unable to access the offerings their home most needed, or would provide them the greatest impacts, due to their status as a renter (Figure 29).

Figure 29. Quotes on Barriers from Participant Interviews

Participation Barriers

Regarding upfront costs as a barrier: "My daughter is a full-time college student, and she works part-time. She pays for her own college and takes care of the household and bills. If my daughter didn't get all her hours, like during the pandemic, we would have to make payment arrangements or get help from social services."

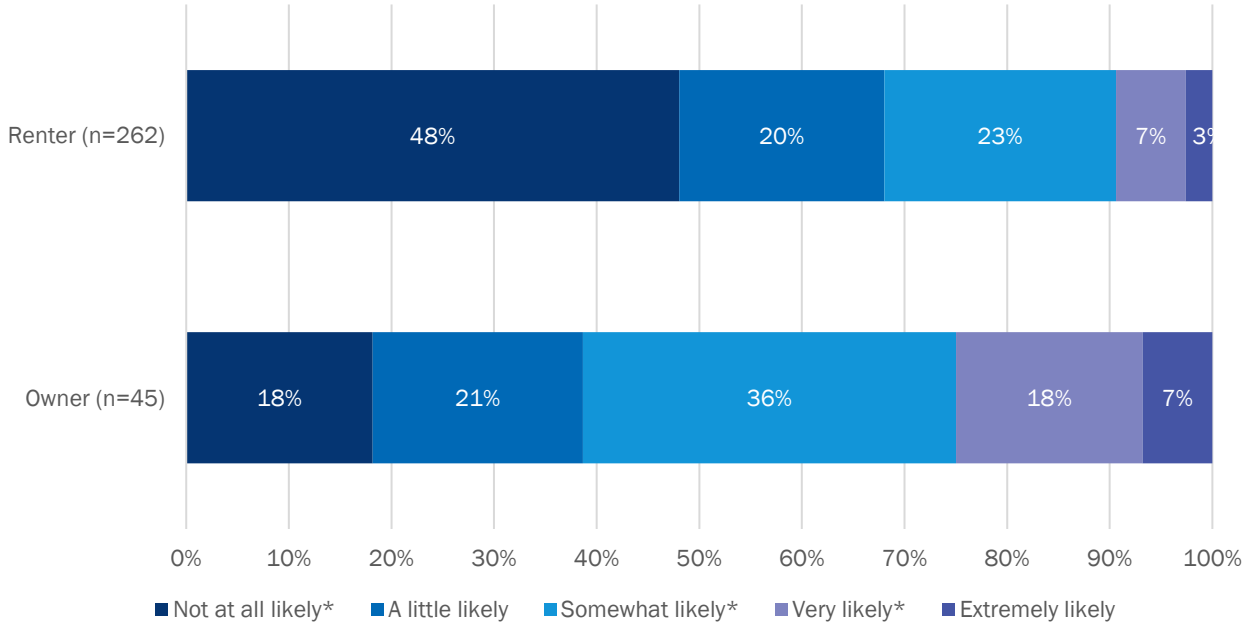
"We had been struggling for so long in our home without heat and air. I have issues with a landlord as he doesn't want to fix things, and when he does, he'll just call somebody or basically get someone off the street."

"If there is a program that is not available to renters for some reason, Duke should try to expand the availability of that program [to include more renters]."

"Duke should put a little bit of muscle into interacting with property owners to the extent that's possible. I believe it falls to Duke to advocate for greater efficiency in rental units."

Most nonparticipants who were renters, regardless of their LMI status, said that their landlord would have to be involved for some of the changes that would make their homes more efficient (96%). Given the need for landlord involvement for nearly all interested renters, landlord communication, approval, and cost sharing were all barriers to participation among this subpopulation. LMI renters were significantly more likely than LMI homeowners to say they were "not at all likely" to make improvements (Figure 30). LMI owners were significantly more likely than LMI renters to say they were "somewhat" or "very likely" to make improvements. Because LMI nonparticipants were significantly more likely to be renters than non-LMI nonparticipants (85% vs. 43%, respectively), Duke Energy will need to address the rental challenge to reach the majority of LMI nonparticipants.

Figure 30. LMI Nonparticipant Likelihood to Make Changes to Make Home More Efficient in the Next Year by Owner/Renter Status



Note: Results based on nonparticipant web survey data – LMI nonparticipants

* Statistically significant difference between groups at a 90% confidence level

Program improvements suggested by nonparticipants did not differ significantly based on LMI status, except for making process eligibility easier to understand, which LMI nonparticipants were more likely to mention than non-LMI nonparticipants. The three most frequent improvements nonparticipants mentioned were (1) making the process easier/clearer, (2) making program eligibility easier to understand/determine, and (3) offering higher/full rebates on energy-efficient products. Both LMI and non-LMI participants agreed with the recommendation of increasing rebate amounts. Slightly less than half (45%) of LMI participants suggested there should be more outreach and education on Duke Energy's program offerings, suggesting they had low program awareness before they participated or would like to learn about additional offerings (Table 18).

Table 18. Participant and Nonparticipant Suggested Program Improvements

Suggested Improvement†	Participants		Nonparticipants	
	LMI (n=173)	Non-LMI (n=130)	LMI (n=265)	Non-LMI (n=157)
Make the Process Easier and Clearer§	23%	32%	51%	44%
Make Program Eligibility Easier to Understand§*	40%	30%	49%	37%
Offer Higher/Full Rebates on Energy-Efficient Products	41%	44%	44%	52%
Increase Outreach and Education Regarding Duke Energy Program Details	45%	37%	31%	30%
Broaden the Range of Energy-Efficient Equipment Offered	36%	41%	20%	23%

Suggested Improvement†	Participants		Nonparticipants	
	LMI (n=173)	Non-LMI (n=130)	LMI (n=265)	Non-LMI (n=157)
Make More Accessible for Renters/More Outreach to Landlords [a]			6%	5%
Other Improvement	5%	6%	3%	2%

§ Statistically significant difference between participant groups at a 90% confidence level

* Statistically significant difference between nonparticipant groups at a 90% confidence level

† Values will not sum to 100% as multiple responses were permitted

[a] Coded from write-in responses in nonparticipant survey analysis; not observed among participant responses

4.4 Impacts of LMI Customer Participation in Duke Energy Programs

Given the challenges that LMI customers face around energy affordability and the need for energy saving home improvements, it is particularly important to understand the impacts of participation in Duke Energy programs among this population. In this section, we provide results from a modeling exercise that estimated the impacts of program participation on customer energy bills using actual Duke Energy customer bills before and after participation in Duke Energy programs. We also provide results of participant survey and in-depth interview questions about the energy and non-energy impacts of participation. These findings demonstrate the impact of Duke Energy programs on LMI customer electric bills and can be used to market the offerings to LMI nonparticipants.

Analysis of Electric Bill Impacts

State of Participant Bills

LMI program participants paid on average $1,600 per year for their electric bills, which averages to just over $133 per month. Electric bill amounts vary depending on participant income. More specifically, participants residing in census block groups with a higher proportion of LMI customers tend to have lower annual bills, likely because their homes are smaller in size. Table 19 summarizes participant annual bills in the year preceding their participation in Duke Energy programs.[16] The data shows average annual bills as well as the annual bills of participants based on the income status of their community grouped into quartiles. More specifically:

- LMI Quartile 1 – includes participants residing in census block groups where 50%-56% of all residents are LMI
- LMI Quartile 2 – includes participants residing in census block groups where 56%-63% of all residents are LMI
- LMI Quartile 3 – includes participants residing in census block groups where 63%-74% of all residents are LMI
- LMI Quartile 4 – includes participants residing in census block groups where 74%-100% of all residents are LMI

While these quartiles are not necessarily indicative of the income status of each participant, they help to portray the neighborhood environment of the participants.

[16] Notably, the year preceding participation is not the same for each participant and is determined by their participation date.

As can be seen in the table, annual bills decrease as the percent of LMI customers in a community increases. This is consistent with the increase of proportion of rental residencies, which also tend to be smaller, across each LMI quartile. This finding likely suggests that lower income customers have lower annual bills which is likely due, in part, to their dwelling size.

Table 19. Participant Bills

Subgroup	Annual Bill Amount ($)
Total	**$1,577**
LMI Quartile 1	$1,628
LMI Quartile 2	$1,608
LMI Quartile 3	$1,557
LMI Quartile 4	$1,515

Over half of participants (58%) were in arrearages at least once over the course of the year preceding their program participation, and a considerable percent were in arrearages for at least four months of the year preceding their program participation (41%). Being in arrearages for four or more months is more likely due to burden rather than forgetfulness to pay electric bills. Average arrears were $71 per month per participant prior to their participation in Duke Energy programs. Notably, the incidence of continuous arrearages as well as average monthly arrears increases by LMI quartile, suggesting that, as incomes in the community decrease, arrears increase in absolute as well as relative terms. In LMI Quartile 4, for instance, participant arrears were an average of $82 per month, accounting for 40% of the total bill, which is $20 per month more than in LMI Quartile 1, where arrears were an average of $62 per month, accounting for under one-third (31%) of participants' average monthly bills.

Table 20. Participant Arrearages

Subgroup	LMI Quartile 1	LMI Quartile 2	LMI Quartile 3	LMI Quartile 4	Total
Average Monthly Arrearage Amount Per Participant	$62	$64	$75	$82	**$71**
Arrearage Amount as a Percent of a Total Monthly Bill	31%	33%	37%	40%	**35%**
Percent of Participants in Arrears at Least Once in a Year Prior to Participation	51%	54%	61%	67%	**58%**
Percent of Participants in Arrears for at Least 4 Bill Periods in a Year Prior to Participation	34%	36%	44%	51%	**41%**

Service disconnections were not common among participants. Overall, few LMI participants (4%) received disconnection notices.

Impact of Program Participation on Participant Bills

Our modeling results show a modest reduction in participant bills due to participation in Duke Energy programs. Following participation, the electric bills of LMI program participants fell by an average of $35 per year or about 2% of total annual electric bill amounts (Table 21). Across 105,327 participants included in the analysis, these bill reductions amount to $3,686,445 in annual bill savings due to Duke Energy programs.

Table 21. Bill Impact Results

Metric	Result
Annual Baseline Bill Amount ($)	$1,581
Average Annual Bill Reduction (%)	$35
% Bill Reduction	2.2%
Total Number of Participants Under Analysis	105,387
Total Annual Bill Reductions Across Participant Population	$3,686,445

As part of the analysis, we explored whether bill impacts vary by the percent of LMI customers in participant census block groups as well as by the ex ante savings expected by Duke Energy from program participation. Ex ante savings serve as a strong indicator of the scope and depth of energy efficient improvements and therefore potential bill impacts. Participants residing in census block groups with a higher percent of LMI customers experienced slightly greater bill reductions (Table 22). The differences are not statistically significantly different. It is important to note, however, that given the lower baseline usage of participants residing in lower-income neighborhoods, bill reductions of the same absolute value are more impactful relative to those participants electric bill costs. This suggests that participants residing in lower income neighborhoods are benefiting from the program participation more in terms of bill reductions. Participants with higher ex ante energy savings (over 700 kWh per year) experience considerably higher bill reductions than participants with lower energy savings (700 kWh or less).

Table 22. Bill Impacts by LMI Quartile and Ex Ante Savings

Subgroup	Annual Baseline Bill Amount ($)	Annual Bill Reduction ($)	% Annual Bill Reduction	Upper Bound	Lower Bound
Total	1,581	$35	2%	$24	$47
LMI Quartile					
LMI Quartile 4	1,523	$38	3%	$53	$24
All Others	1,610	$34	2%	$46	$23
LMI Percentile					
LMI 90% Percentile	1,421	$45	3%	$63	$26
All Others	1,608	$34	2%	$46	$23
Ex Ante Energy Savings					
Ex Ante Energy Savings Quartile 4	1,659	$51	3%	$66	$36
All Others	1,382	$31	2%	$42	$19

In addition to estimating the impact of Duke Energy programs on participation, we also explored the impact of program participation on arrearages. We were unable to complete the modeling efforts due to the incidence and variation in arrearages. Instead, we pursued a descriptive analysis of arrearage trends in treatment and comparison groups before and after program participation.

Our analysis suggests that participating in Duke Energy programs provides a modest reduction in arrearages, especially as related to participants with high arrearages. More specifically, our exploration of changes in arrearages among participants in the top 85th percentile with the highest annual arrearage (referred henceforth as participants with severe arrearage issues) shows that 83% participants had reduced their arrearages and were no longer in a severe arrearage situation a year later (Table 23). Among comparable nonparticipants, slightly fewer, 78%, had reduced their arrearages. We found little difference between

participants and nonparticipants who were not in arrears. Few entered into arrears a year later regardless of participation status (7% of nonparticipants compared to 8% of participants).

Table 23. Incidence of Severe Arrearages Before and After Program Participation

Customer Type	Number of Participants Prior to Participation in Duke Energy Programs	Number of Participants Following Participation in Duke Energy Programs	Difference	% Difference	Difference In Difference
Customers with Severe Arrearages Prior to Program Participation					
Participants	1,170	196	974	83%	5%
Similar Nonparticipants*	2,195	475	1,720	78%	
Customers without Severe Arrearages Prior to Program Participation					
Participants	12,445	11,409	1,036	8%	1%
Similar Nonparticipants*	12,827	11,928	899	7%	

*Note that due to being non-participants, these customers did not participate in Duke Energy programs. Periods prior to program participation and following program participation for non-participants therefore are taken from their respective participant matches in order to make relevant comparisons.

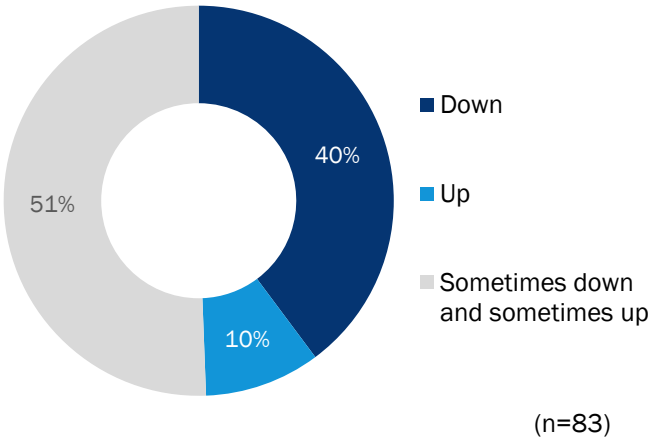
Participant Reported Impacts

Electric Bill Impacts

LMI participants were less likely to report a consistent decrease in their electric bills compared to non-LMI participants after participating in a Duke Energy program. Of all LMI participants surveyed, about one in five (21%) noted a consistent electric bill decrease after participation compared to 29% of non-LMI participants. While equal percentages of LMI and non-LMI participants observed any changes in their electric bills after participating, a greater share of non-LMI participants noticed a consistent reduction in their bills compared to LMI participants.[17] Just over half (53%) of LMI participants report any type of change in their electric bills after participating in a Duke Energy program, compared to 49% of non-LMI participants. LMI participants are more likely than non-LMI participants to indicate that their year-round electric bills *increased* or were *variable* since participating in a Duke Energy program (Figure 31), whereas non-LMI participants are more likely to report a consistent reduction in their electric bills (Figure 32).[18]

[17] Although the survey question asked respondents to reflect on bill changes due to their participation, residential rate increases that took effect in 2019 (SC) and 2021 (NC) may impact customer bills and therefore responses to questions surrounding bill impacts.
[18] Of LMI participants who report a change in their bill, over half (51%) say it was fluctuating throughout the year. LMI participants with variable bills after participation are more likely to say their bill decreased in the winter (25%) than the summer (17%). However, most LMI participants with fluctuating electric bills indicate that their bill was variable within individual seasons as well as year-round (49% and 53% for summer and winter respectively).

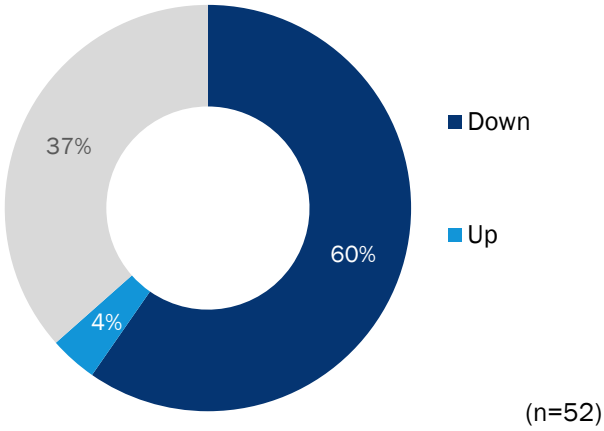
Figure 31. Direction of Electric Bill Change for LMI Participants



Note: Results based on participant web survey data – LMI participants who saw a change in their bill as a result of their participation

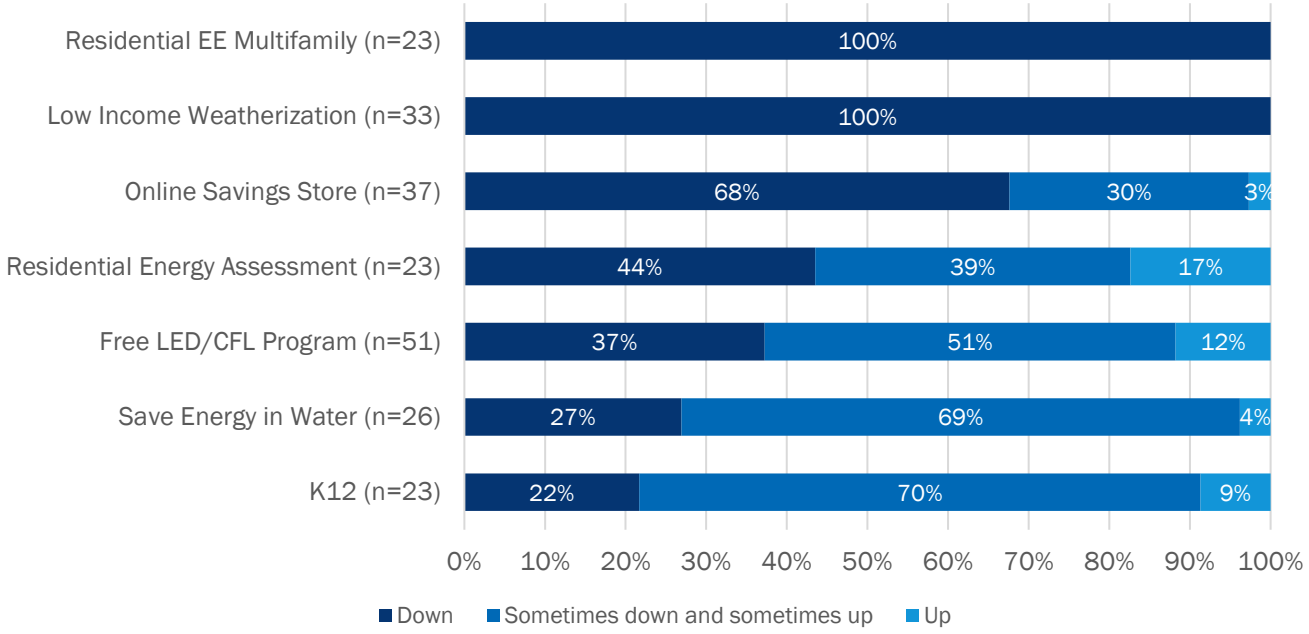
Figure 33 shows the direction of electric bill impacts reported by participants by program. Notably, all participants who reported changes in their bill as a result of their participation in the Residential EE Multifamily and Low-Income Weatherization programs reported their bills went down year-round. Over half of Online Savings Store participants who saw a change in their bill also report it being consistently lower. Participants' perceived bill impacts for the Residential Energy Assessment, Free LED/CFL Program, Save Energy in Water, and K12 program are more variable with the majority saying their bill went both up and down or consistently up throughout the year.

Figure 32. Direction of Electric Bill Change for Non-LMI Participants



Note: Results based on participant web survey data – non-LMI participants who saw a change in their bill as a result of their participation

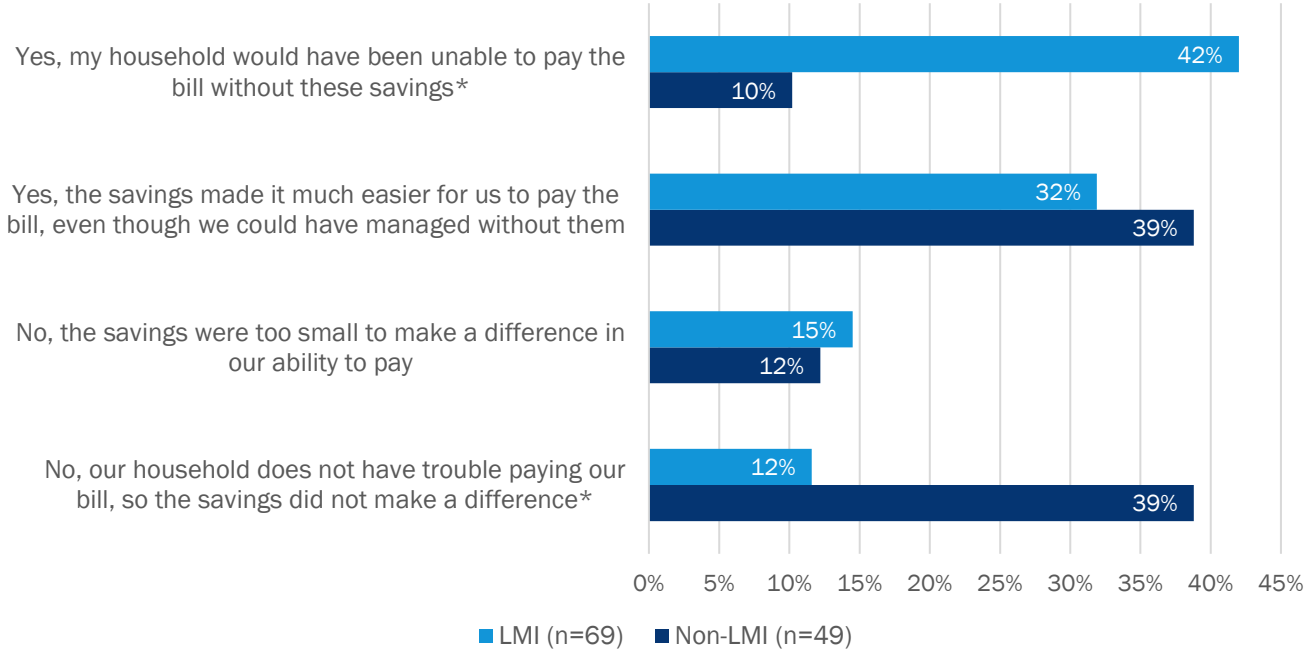
Figure 33. Direction of Reported Electric Bill Impacts by Program



Note: Figure presents direction of change in bills for those programs where n>20. Results are not broken down by LMI status as it would result in insufficient comparison group sizes. Results based on participant web survey – respondents who saw a change in their bill as a result of their participation

Despite experiencing less consistent savings, LMI participants are more likely than non-LMI participants to report that the electric bill savings they do experience affect their household's ability to pay their bills (Figure 34). Notably, LMI participants are significantly more likely than non-LMI participants to indicate that they would not have been able to afford to pay their electric bills without the savings associated with their participation (42% vs. 10%). Additionally, only 12% of LMI participants indicate that the savings did not affect their ability to pay their electric bill because they did not have any issues affording the bill already, compared to 39% of non-LMI participants. This suggests that savings associated with participating in a Duke Energy program are more financially meaningful to LMI customers than non-LMI customers.

Figure 34. Impact of Savings on Participants Ability to Pay Electric Bill



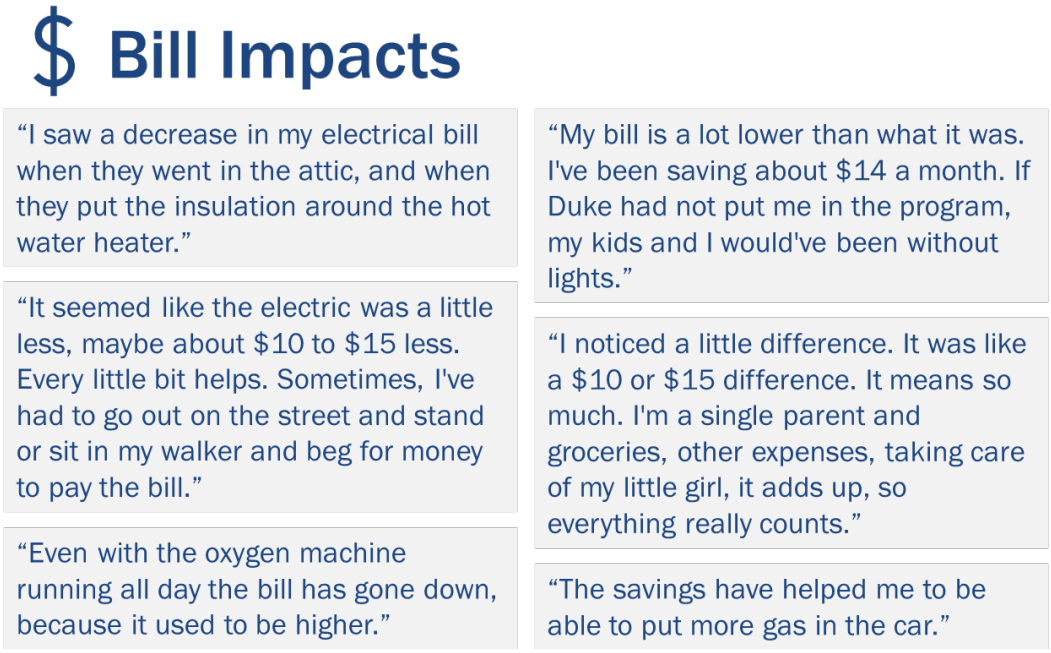
Note: Results based on participant web survey data - participants who saw a change in their bill as a result of their participation

* Statistically significant difference between groups at a 90% confidence level

LMI and non-LMI participants who experienced electric bill savings were equally satisfied with the amount of savings. On a 0 to 10 scale where 0 represents extremely dissatisfied and 10 extremely satisfied, the average satisfaction score for LMI participants was 8.3 compared to 7.9 for non-LMI participants.

In-depth interviews with participants reinforce the finding that LMI participants are more attuned to their electric bill amounts and notice even small decreases. Interviews also support the conclusion that bill savings among LMI customers, even when savings are not consistent from month to month, have meaningful impacts on customers' lives (Figure 35).

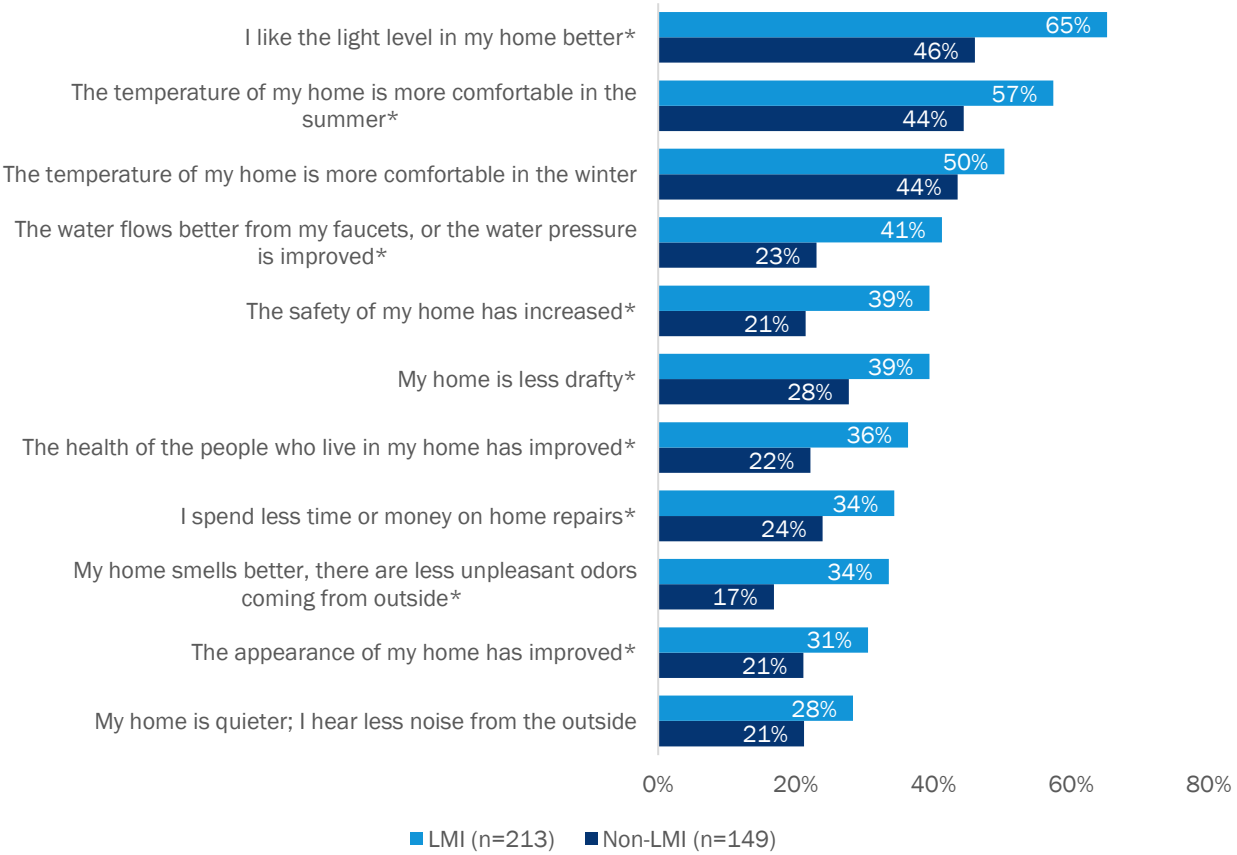
Figure 35. Quotes on Bill Savings from Participant Interviews



Non-Energy Impacts

LMI participants report a greater number of non-energy impacts (NEIs) because of their participation in Duke Energy programs (5.7 on average) compared to non-LMI participants (4.6 on average). We asked about eleven possible NEIs in the participant surveys. For 9 of the 11 impacts, LMI participants were significantly more likely than non-LMI participants to say they experienced an impact (Figure 36). The most frequent impacts that LMI participants noticed were better light quality (65%) and more comfortable home temperatures during the summer (57%) and winter (50%). Most LMI participants also report intangible impacts such as increased knowledge about their energy consumption (71%) and feeling that they are helping the environment (78%).

Figure 36. Non-Energy Impacts Participants Experienced†



Note: Results based on participant web survey data – participants that provided valid NEI selections

* Statistically significant difference between groups at a 90% confidence level

† Values will not sum to 100% as multiple responses were permitted

In-depth interviews with participants support the finding that LMI customers experience meaningful NEIs beyond bill impacts due to their participation in Duke Energy's programs. While many participants reported positive benefits from measures such as lighting (Figure 37) and low-flow showerheads (Figure 38) and were satisfied with their experiences, a few were less satisfied. Some participants noted that their participation decreased maintenance projects and costs, though one participant noted that participating made him aware of additional projects and energy efficiency upgrades that are needed (Figure 39).

Figure 37. Quotes on Lighting NEIs from Participant Interviews

Lighting Impacts

"I took out all my old light bulbs and the new light bulb were brighter and used a lot less energy."

"The lighting is much better. I can see better. I do a lot of puzzles and numbers, so it's good when it comes to that. "

"The bulbs were a little bit dim. It wasn't as bright as I like it, but I knew it wasn't costing me as much, so that was a positive to me."

"The light bulbs they brought were doing great and were very efficient, but I ended up giving them away because they gave off a cold, white light."

Figure 38. Quotes on Water Measure NEIs from Participant Interviews

Water Impacts

"My daughter takes longer showers, so that's helpful because now when she takes long showers it's not pouring out as much water."

"I was happy with the showerhead, but I wanted one that had a longer, standard hose on it."

"Putting the showerheads on was easy and using them is a good experience. The water comes out better."

"The showerhead that they brought enraged me. It is low flowing and prefer something that flows a lot."

Figure 39. Quotes on Home Maintenance NEIs from Participant Interviews

Maintenance Impacts

"Because of the air filter I only need to clean the air conditioner every other year instead of every year."

"The LEDs lasted for a good while before I had to switch them out. They saved me on buying bulbs for a while."

"My participation has added additional projects to the list, some that have been done and more that are left to do. It increased my awareness of additional projects."

"I'm still using the light bulbs Duke gave us to this day. They gave us a ton and they last a long time. We haven't had to go out and buy any light bulbs for two years."

Some of the most meaningful NEIs reported by participants had to do with the comfort of their home (Figure 40) and improved health and safety (Figure 41). Participants who received measures to improve the envelope of their home or upgrade their heating or cooling systems noticed the benefits beyond energy savings and shared examples of the impact on their household, their health, and their day-to-day life.

Figure 40. Quotes on Temperature/Comfort NEIs from Participant Interviews

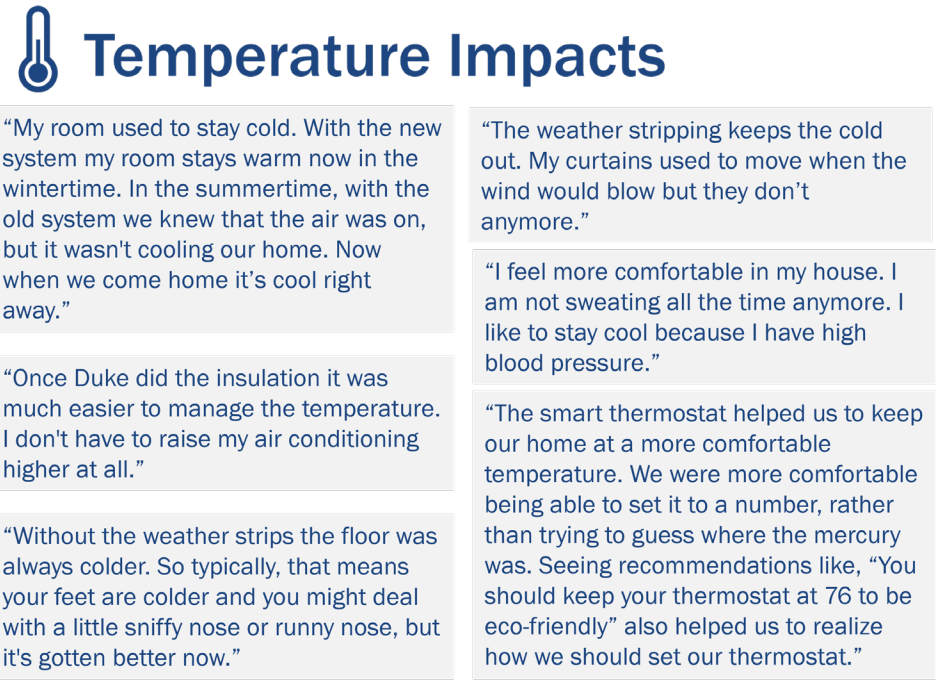


Figure 41. Quotes on Health and Safety NEIs from Participant Interviews

5. Key Findings and Recommendations

5.1 Key Findings

- LMI customers have different demographic and housing characteristics, on average, than non-LMI households. Our analysis of census, Duke participation, survey, and in-depth interview data reveals that these differences affect LMI customers' energy efficiency needs, program participation barriers and motivations, and the magnitude of program participation impacts.
- Our analysis of census data and neighborhood participation rates from 2013 through 2021 found that average annual participation in Duke Energy programs was slightly lower in neighborhoods that have a moderate to high percentage of LMI households compared to those with few LMI households. Program participation was lowest in neighborhoods that have a moderate percentage of low income household customers. In neighborhoods where between 40% to 50% of households are LMI, an average of 8.29% of households participated in Duke Energy programs each year compared to 8.99% in neighborhoods with a high percentage of LMI households (90% or more) and 10.48% of households in neighborhoods with few LMI households (less than 10%).
  - Both moderate and high LMI neighborhoods have lower participation rates in market rate programs (~ 8%) compared to low LMI neighborhoods (~10%). But in high LMI neighborhoods, a small but meaningful percentage of households (~1%) participate in low income programs, which somewhat makes up for their lower participation in market rate programs. In neighborhoods with a moderate percentage of LMI households, fewer participate in low income programs (less than 0.5%).
  - We found a similar difference in participation rates in programs with high energy savings. We found that 2.9% of customers who live in neighborhoods with a high concentration of LMI households participate in high savings programs compared to 3.7% of customers who live in neighborhoods with few LMI households.
- Our analysis of results from participant and nonparticipant surveys finds that Duke Energy programs struggle to reach historically hard-to-reach and frequently disadvantaged populations, namely renters, residents of multifamily properties, and more transient populations. The majority of participants, both LMI and non-LMI, are homeowners and live in single family homes. Living in a rented or multifamily home compounds the participation barriers for LMI customers.
  - We found that LMI program participants were much more likely to own their homes than LMI non-participants. Just over half of LMI participants (52%) are homeowners compared to 15% of LMI non-participants. Similarly, just under two-thirds of LMI participants (64%) live in a single-family home compared to just over one-quarter of LMI non-participants (28%).
  - Non-LMI participants are also more likely to be homeowners compared to non-LMI nonparticipants (86% vs. 57%). Non-LMI participants are more likely to live in single family homes compared to non-LMI nonparticipants (81% vs. 53%).
- Nonparticipant survey results show that LMI customers have greater energy efficiency needs and concerns than non-LMI customers.
  - One-third of LMI nonparticipants (33%) said "a lot of things" in their homes could be made more energy efficient, compared to only 16% of non-LMI nonparticipants.

  - LMI nonparticipants were more concerned about their energy usage than non-LMI nonparticipants. Half of LMI nonparticipants (49%) were either "very" or "extremely concerned" about their household energy use, compared to slightly under one-third (30%) of non-LMI nonparticipants.

- Despite a greater need for energy efficiency improvements, participation barriers among LMI customers are more pronounced compared to non-LMI customers and include program awareness, knowledge, cost constraints, and being a renter. Our survey results suggests that, with the support of a program that addresses their barriers to structural upgrades, LMI nonparticipants would be likely to make energy efficiency improvements to their homes. However, barriers such as split incentives and limited financial resources may inhibit LMI customers from seeing high-savings programs as a realistic possibility for their household.
  - LMI nonparticipants are less likely to be aware of Duke Energy programs compared to non-LMI nonparticipants (40% vs. 64%). Nonparticipants had low awareness of energy efficiency opportunities in general, with LMI customers reporting lower awareness than non-LMI customers. Over half of LMI nonparticipants (55%) said they were either not at all knowledgeable or had only a little knowledge about ways to save energy in their homes compared to 45% of non-LMI nonparticipants
  - More LMI nonparticipants say that they are "not at all likely" to make changes to their home to make it more efficient in the next year compared to non-LMI nonparticipants (43% vs. 28%).
  - When presented with specific offerings from Duke Energy, LMI nonparticipants were more likely than non-LMI nonparticipants to say they were "very" or "extremely" likely to participate in any type of Duke Energy program in the next two years. LMI nonparticipants were most interested in no-cost or low cost upgrades such as lighting or free upgrades based on income and least interested in higher cost and higher savings opportunities such as heating and cooling system rebates.
  - LMI and non-LMI nonparticipants have different barriers to program participation. LMI nonparticipants were more likely than non-LMI nonparticipants to say that the cost of participation, their lack of authority as a renter, and the COVID-19 pandemic were barriers to their participation
- Our modeling of LMI customer energy bills before and after participation in Duke Energy programs, revealed modest electric bill savings for customers who participated in Duke Energy programs. Following program participation, the electric bills of LMI customers fell by an average $34 per year, or about a 2% annual bill reduction ($1,600 is the average annual bill for LMI participants).
- One in five LMI participants reported a consistent reduction in their electric bills after participating in a Duke Energy program, which is somewhat lower than what non-LMI participants reported (21% vs. 29%). Survey results and in-depth interviews with LMI participants report these reductions have a greater impact on their household finances given their lower incomes.
  - LMI participants are significantly more likely than non-LMI participants to indicate that they would not have been able to afford to pay their electric bills without the savings associated with their participation (42% vs. 10%). One participant reported, "My bill is a lot lower than what it was. I've been saving about $14 a month. If Duke had not put me in the program, my kids and I would've been without lights."
- LMI customers are satisfied with their program participation experience and are more likely to report non-energy impacts (NEI) from participation than non-LMI customers.
  - The most frequent impacts that LMI participants noticed were better light quality (65%) and more comfortable home temperatures during the summer (57%) and winter (50%).

5.2 Study Recommendations

- **Duke Energy should continue to offer low income programs in addition to their market rate offerings.** Duke Energy's low income programs play an important role in supplementing market rate programs in neighborhoods with a high percentage of LMI customers.
- **Duke Energy should consider expanding their low income offerings to reach more low income customers outside of neighborhoods with a high concentration of LMI customers.** The neighborhood-based low income programs are less effective at reaching customers in neighborhoods that have a moderate yet still sizable percentage of low-income customers.
- **Duke Energy should utilize existing LMI networks and leverage word-of-mouth outreach from satisfied participants to increase program awareness and participation.** LMI participants report receiving critical energy and non-energy benefits due to participating in Duke Energy programs. Duke Energy could encourage past participants to share their stories with friends, family, and neighbors. . Duke Energy could also consider featuring testimonials about the benefits of participation from past participants in marketing materials.
- **To increase program participation among LMI customers, Duke Energy should enhance their low income program efforts to reach the sub-segments of LMI customers who are most underserved, focusing on renters and multifamily residents.** LMI renters and residents of multifamily properties are less likely to participate than comparable owners and single-family customers. Program enhancements could include outreach to landlord and property owners either directly or on behalf of tenants and adding measures to existing multifamily programs that would provide greater energy savings.
- **Duke Energy should consider either adding a program specifically for moderate income customers or programs that would reduce the up-front investments required for high savings programs.** Moderate income customers could benefit from an on-bill financing program that would spread initial upgrade costs out over time.
- **Duke Energy should consider prioritizing new program offerings that provide support for measures that LMI customers report as most needed.** LMI nonparticipants report that they could most benefit from upgrades to their HVAC equipment, home weatherization, and energy efficient windows.

For more information, please contact:

Danielle Fulmer
Principal Consultant

617-492-1400 tel
dfulmer@opiniondynamics.com

1000 Winter Street
Waltham, MA 02451

Opinion Dynamics

Boston | Headquarters

617 492 1400 tel
617 497 7944 fax
800 966 1254 toll free

1000 Winter St
Waltham, MA 02451

Duke Energy Carolinas (DEC) and Duke Energy Progress (DEP) Low and Moderate Income Penetration Study

Study Report – Appendices

December 9, 2022

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Appendix A. Detailed Maps

This section includes all maps produced as part of the geospatial analysis. Data is summarized at the Census block group level. Due to the small and concentrated nature of Census block groups in urban areas, we provide visuals for six major urban areas in the Carolinas following the territory-wide visual for each topic.

Figure 1. Proportion of LMI Households in Block Group

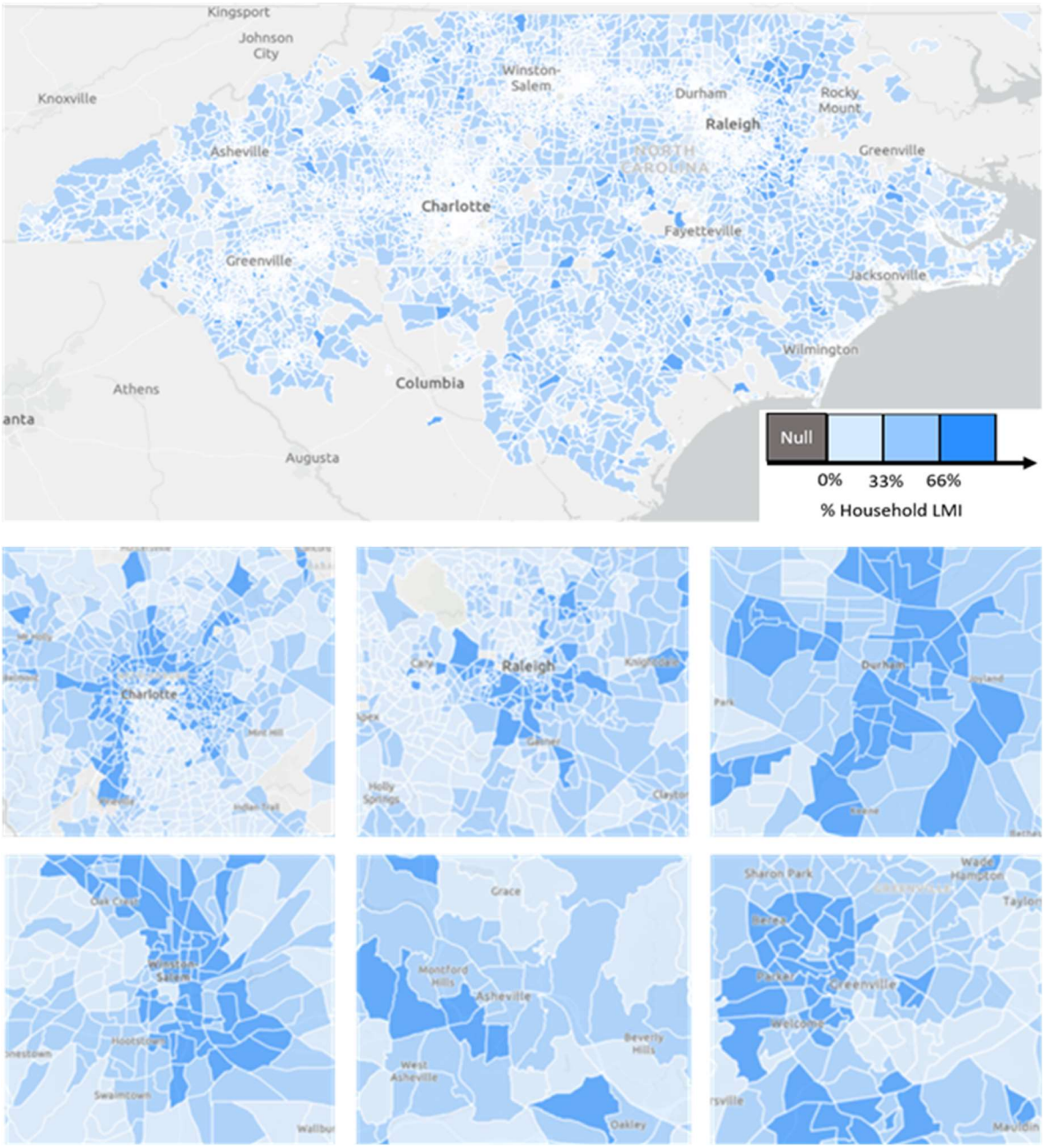


Figure 2. Duke Energy Program Participation Rate in Block Group

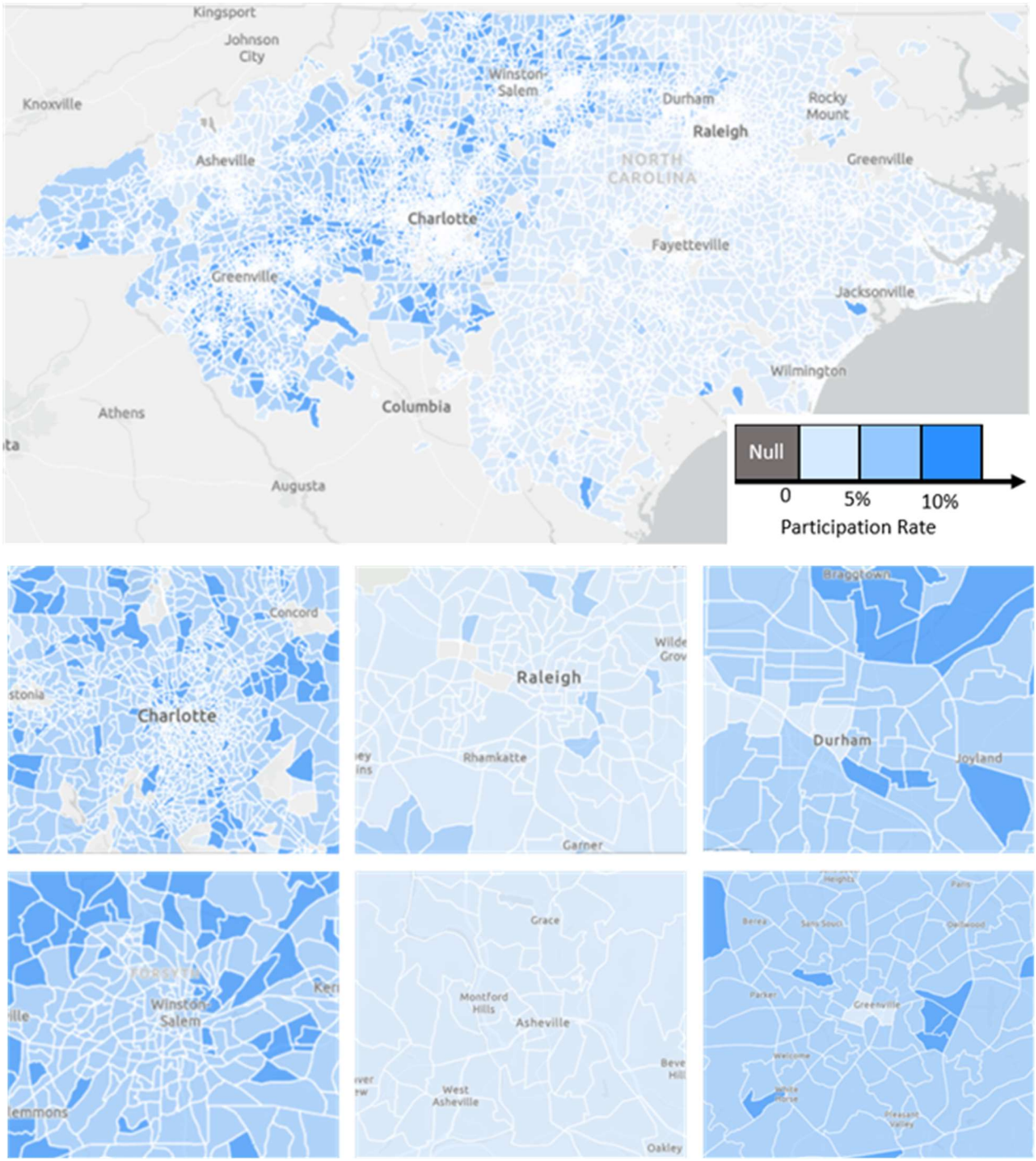


Figure 3. Participation Rate Compared to LMI Households

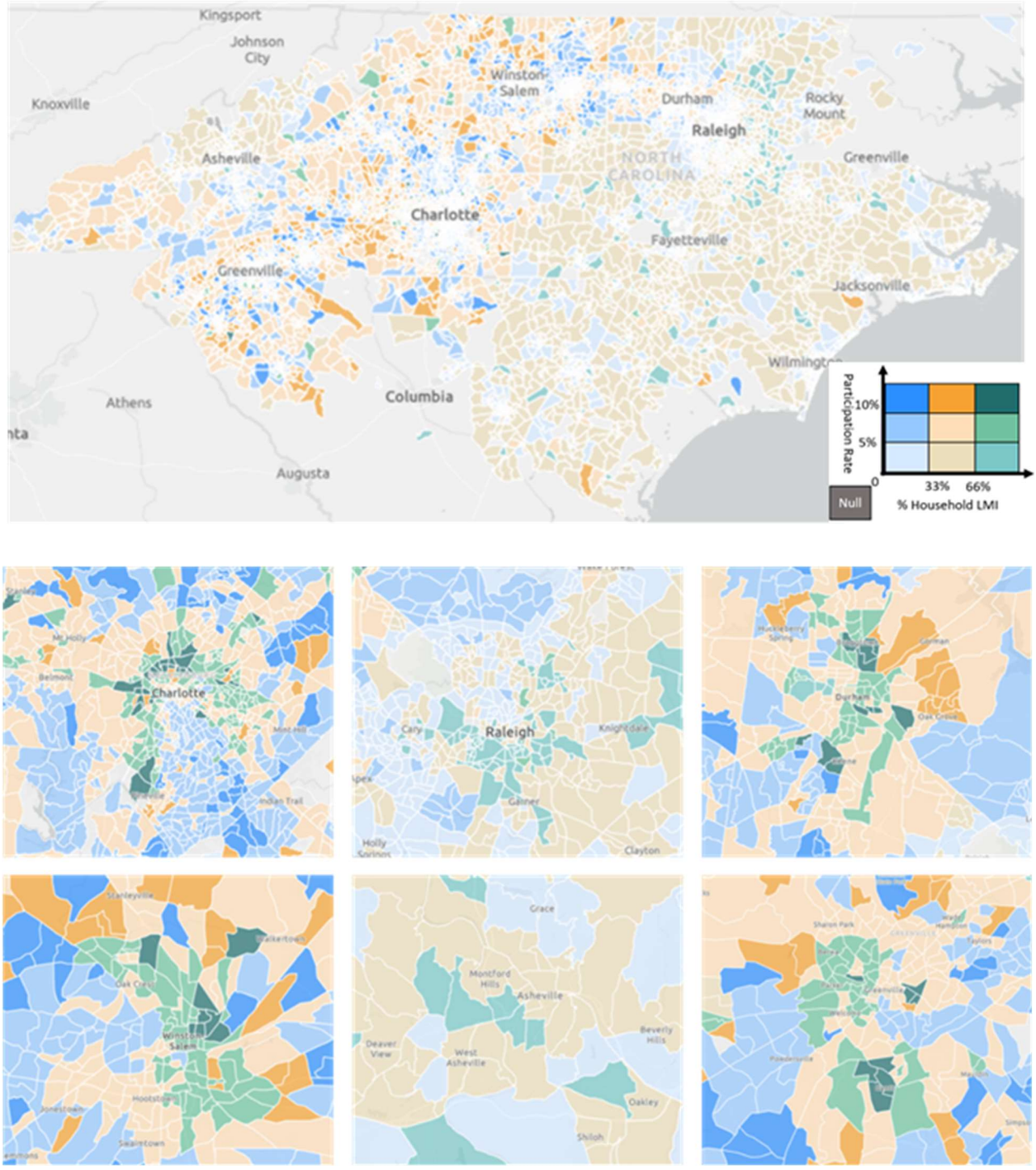


Figure 4. Participation Rate Compared to Ex Ante Savings

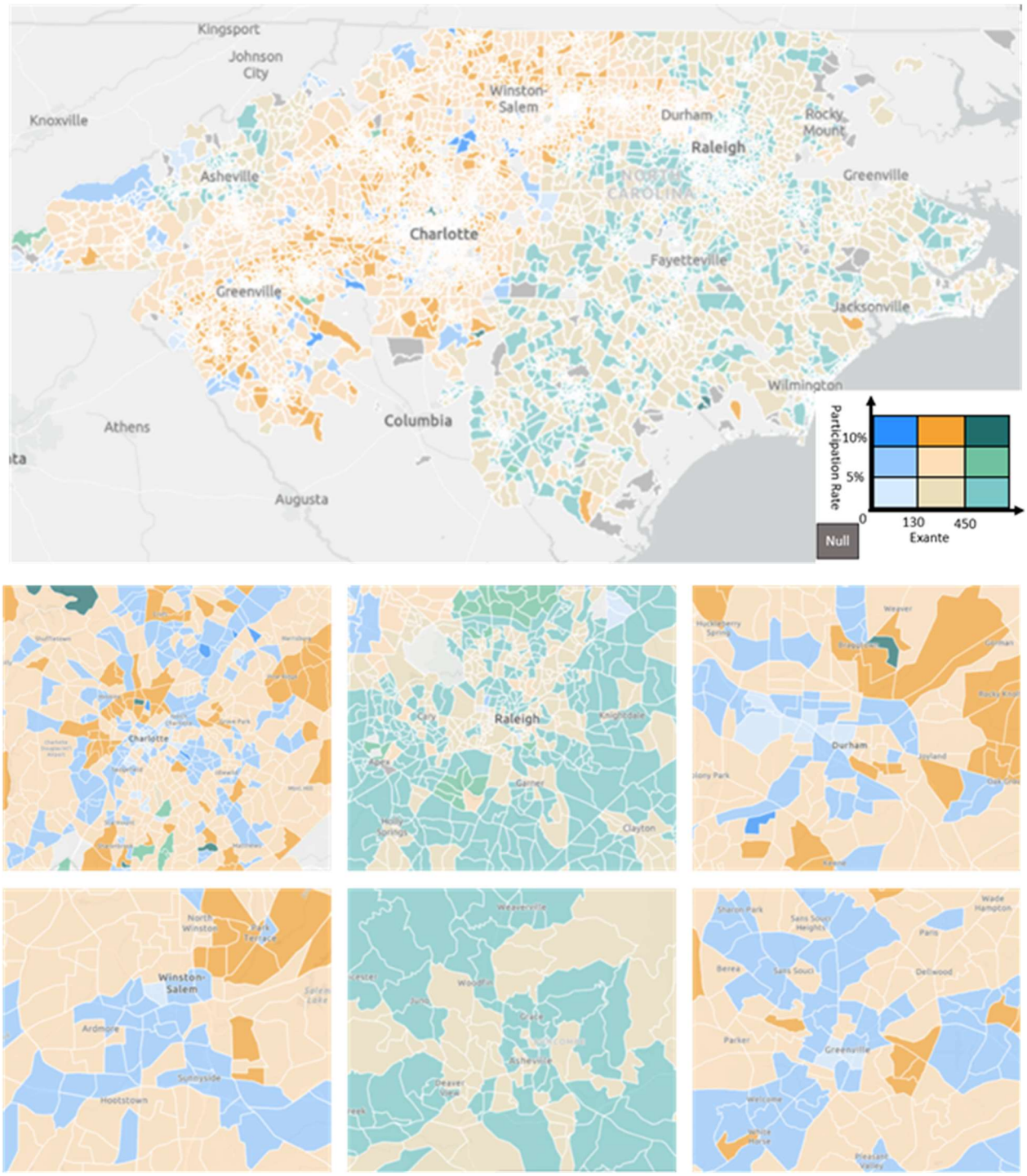


Figure 5. Participation Rate Compared to Single Family Homes

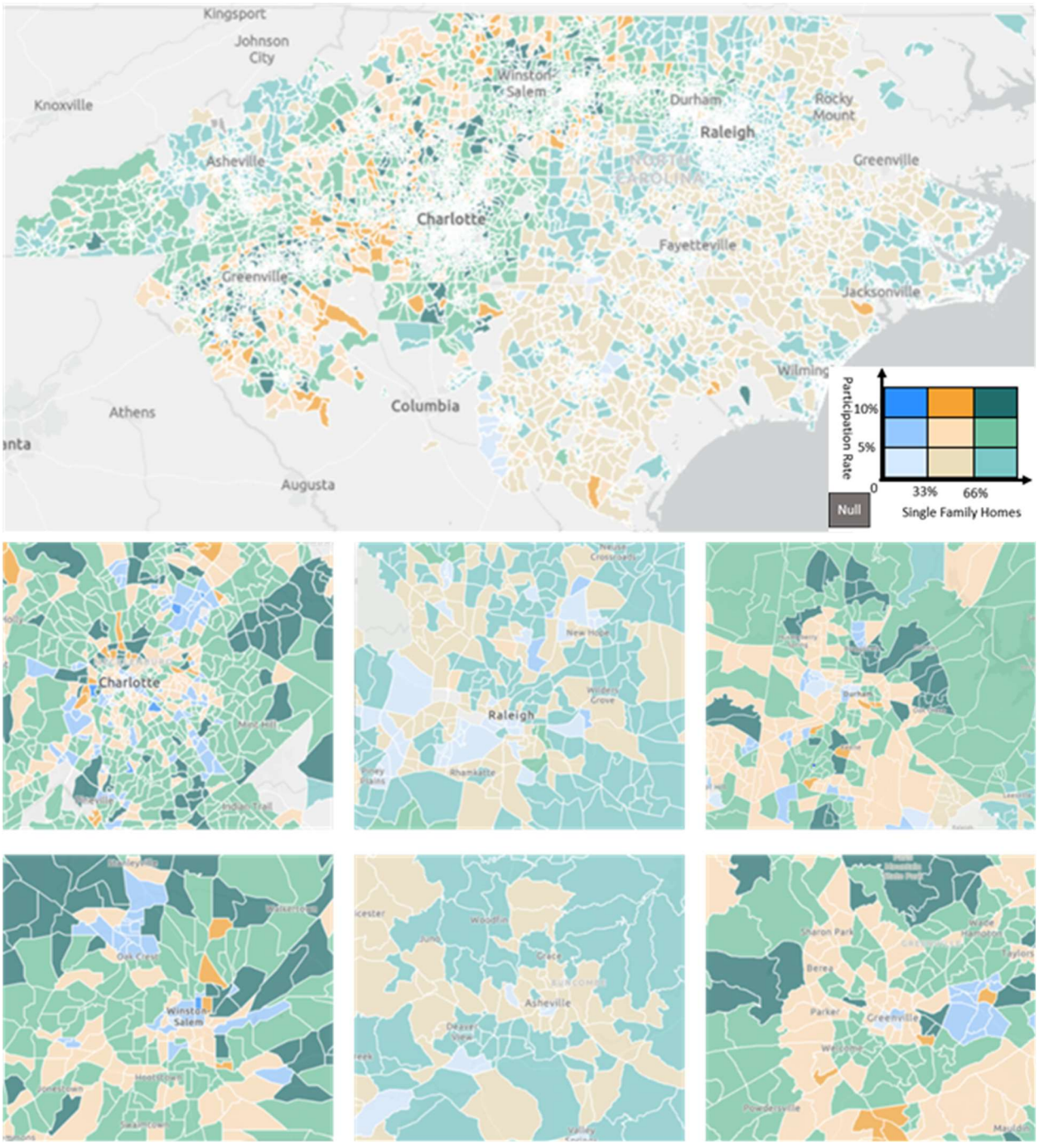


Figure 6. Participation Rate Compared to Owner Occupied Homes

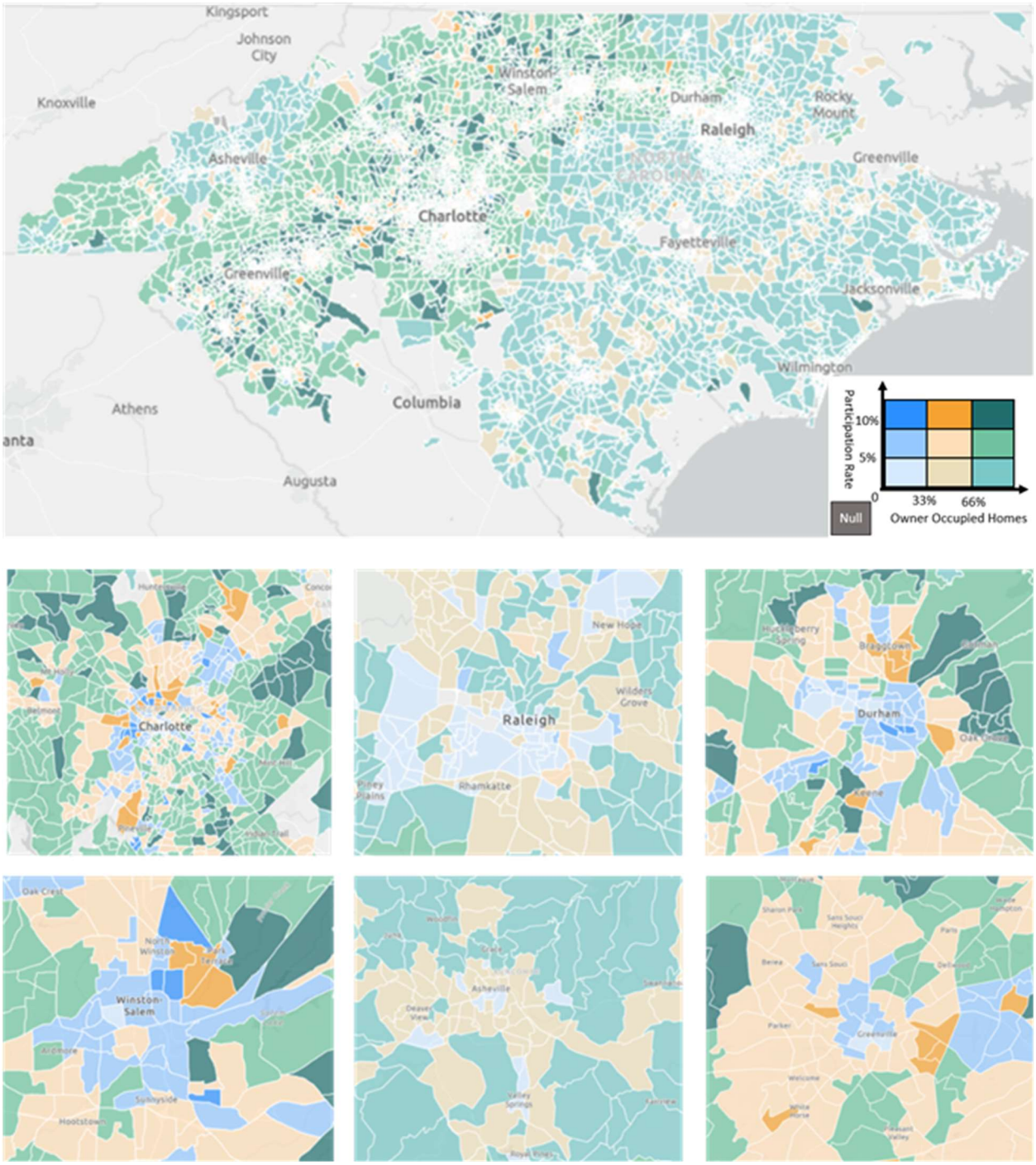


Figure 7. Participation Rate Compared to Nonwhite Population

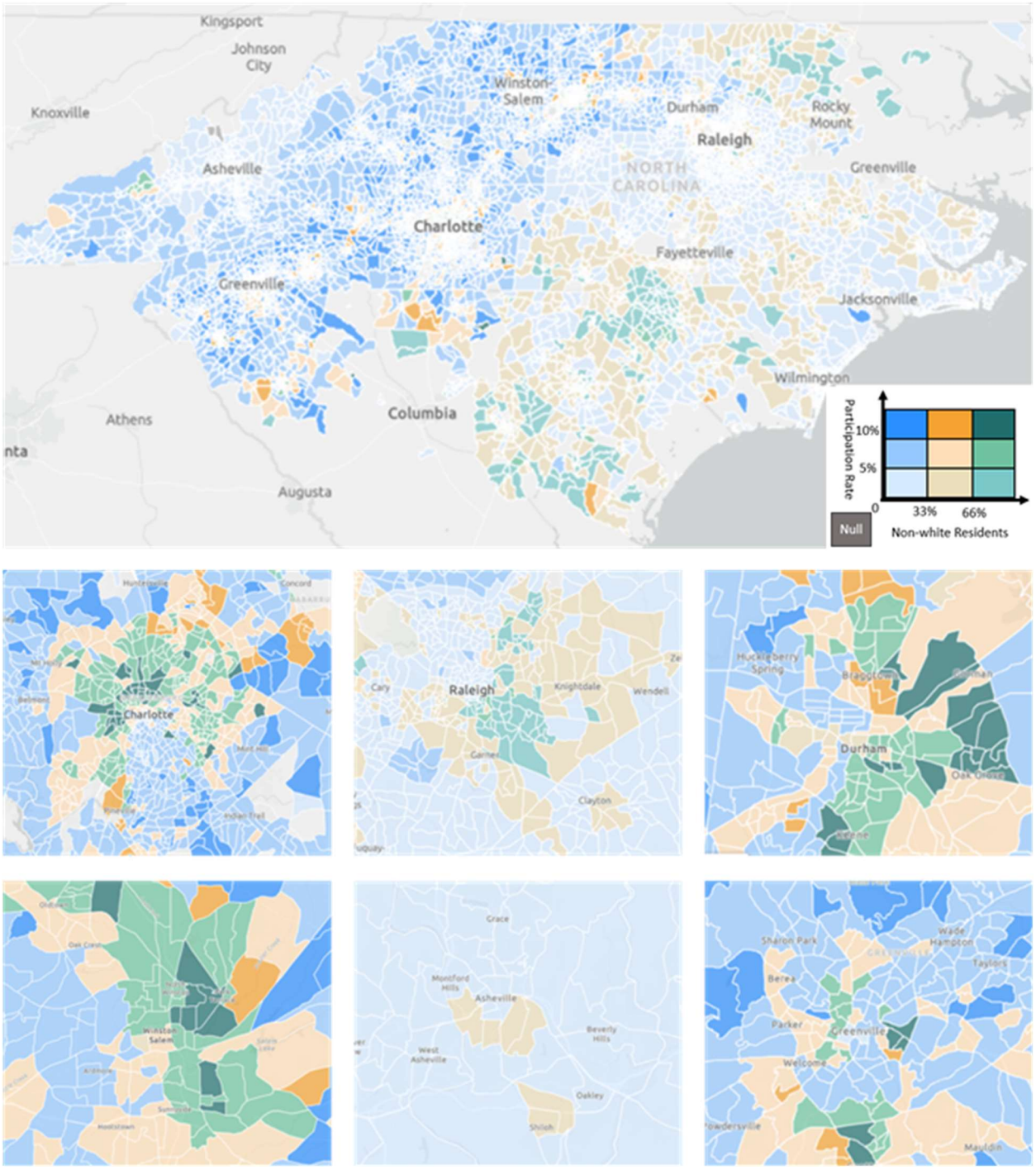


Figure 8. Participation Rate Compared to Household Energy Burden

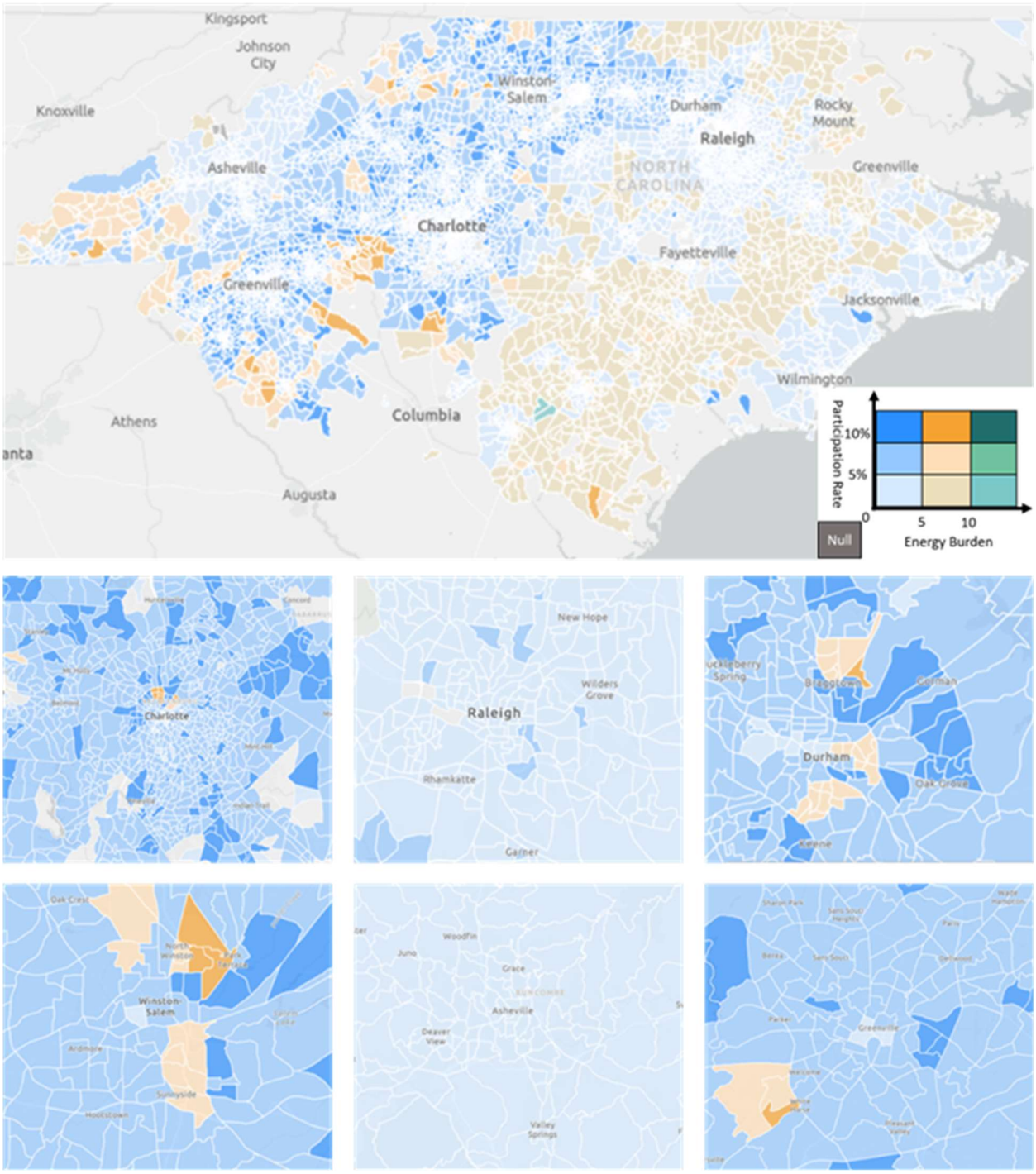


Figure 9. Participation Rate Compared to Limited English Proficiency Households

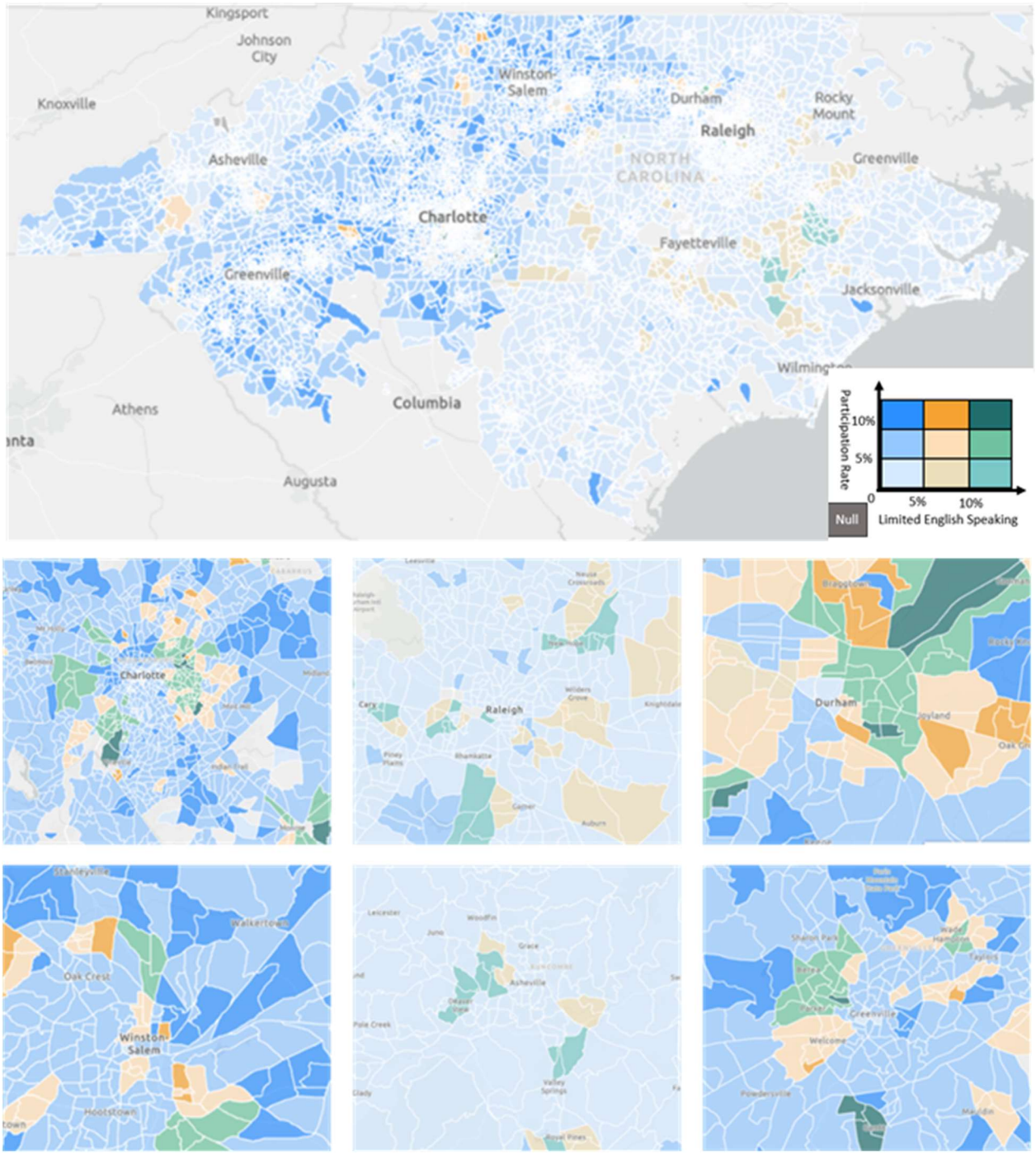
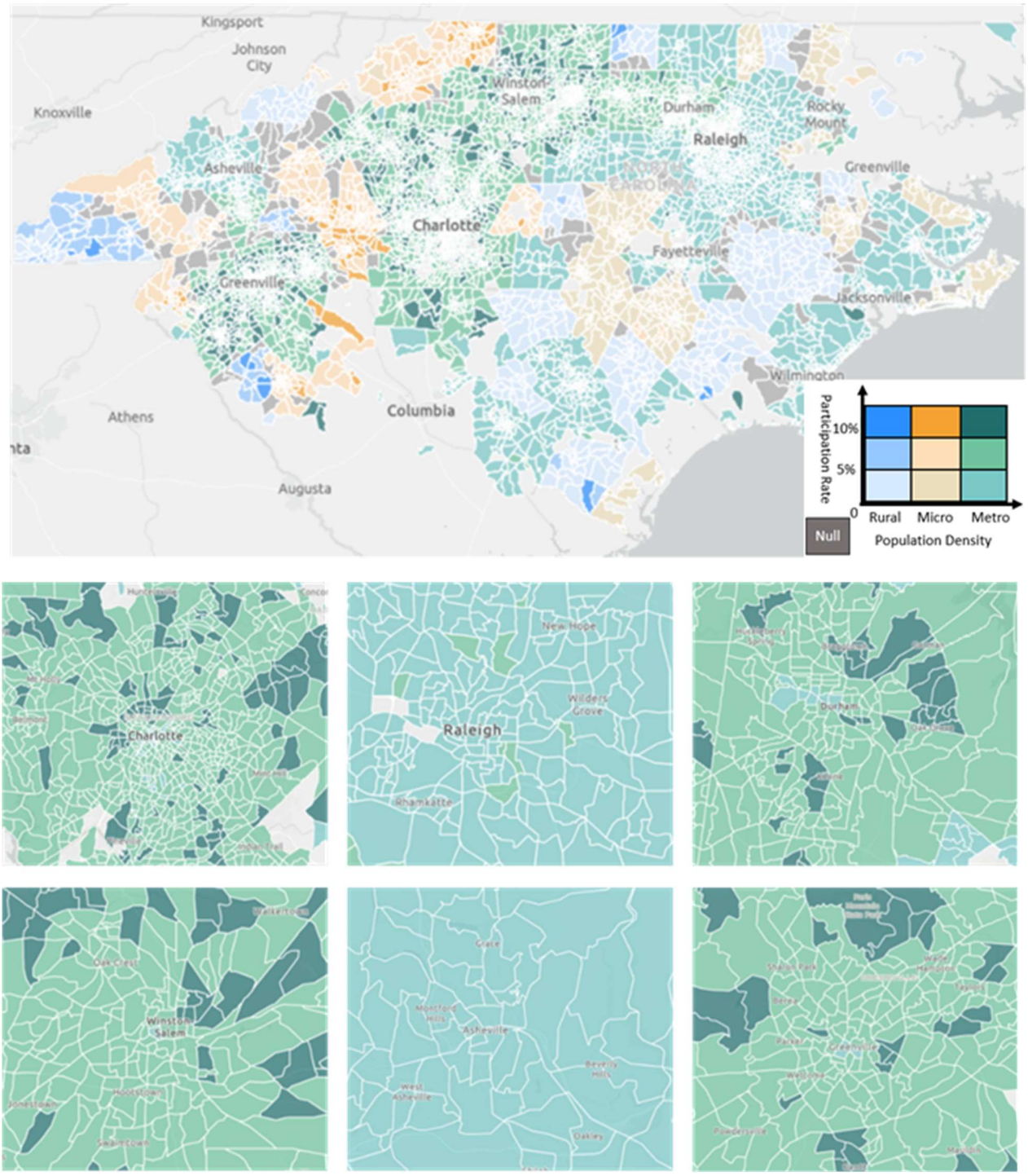


Figure 10. Participation Rate Compared to Population Density



Appendix B. Program Participation Model Detailed Methods

Data Cleaning and Preparation

The participation modeling analysis was completed with the Census block group as the unit of analysis. This unit of analysis was selected because the majority of the observed data on housing and demographic characteristics was unavailable for individual Duke Energy households.

We completed the following steps to prepare the data for analysis:

- Identified participants and nonparticipants by year. We flagged customers as having either participated or not participated in a given year and did not further identify customers who participated in more than one program.
- Aggregated household level data to the Census block group and year level. For example, we took the average per-participant ex ante savings and calculated block group level savings by year. We excluded 2021 due to much lower participation rates compared to previous years.
- Transformed all independent variables from continuous to indicator values by analyzing the distribution of the variable and setting a threshold for defining the block group as having a high or low incidence of this characteristic
  - Generally, we selected either the 75th or 90th percentile of the variable to define the indicator. For example, if the 90th percentile of Census block groups are comprised of 73% or more nonwhites; the nonwhite flag was set at 73% or higher.
  - The 90th percentile was chosen if there was a large gap between the 75th and 90th percentiles.
  - If the 75th & 90th percentiles were close, the 75th percentile was selected as the cutoff.
- The dependent variable, which was the participation rate in low or high savings offerings, respectively, was retained as a continuous variable.

The total number of Census block groups included in the analysis after data cleaning were 5,679 (86.5%).

Model Specification

The purpose of the participation model was to identify household and demographic characteristics associated with participation in Duke Energy programs at the Census block group level. The dependent variable was the average annual participation rate in the block group. We fit separate linear regression models for high savings and low savings programs (as defined by average per-household ex ante savings values) as we found that different characteristics drive participation in high vs. low savings offerings and higher savings offerings also have different impacts on participants.[1]

Independent variables were selected for inclusion in the model based on the results of descriptive analysis including examining correlations and trends between participation rate and percentage of LMI households for each variable. The independent variables were constructed as indicator variables to identify neighborhoods that stand out on sociodemographic, housing, and energy consumption characteristics. The use of indicator variables allows us to isolate the explanatory power of these characteristics by focusing on neighborhoods

[1] Due to fluctuating savings values over time, savings were defined as high savings if they were greater than or equal to average per-participant savings in that year, and as low savings if they were less than average.

where they are prevalent. The indicator variables effectively reduce "noise" in the neighborhood-level data. The models did not include any interaction terms as we found that these did not improve fit at the neighborhood level. Ultimately, we did not include the percentage of LMI households in the neighborhood as an independent variable. We tested models with and without this term and found that given the high correlation between LMI status and other sociodemographic and housing characteristics, models without LMI status provided better predictive power and allowed us to isolate the underlying characteristics that explain program participation rates.

After testing a variety of models, we selected the specification presented in Equation 1. Models were assessed on fit. The best model had an r-squared value of 0.16, meaning that it explains 16% of the variation in program participation rates between Census block groups. The low r-squared is likely due to: (1) the neighborhood analysis obscures important household-level variation and reduces predictive power and (2) unobserved characteristics and events that contribute to variation in program participation rates.

Equation 1. Participation Model Specification

$$ParticipationRate_{it} = B_1 + B_2 + B_3 + B_4 + B_5 + B_6 + B_7 + B_8 + B_9 + B_{10} + B_{11} + B_{12} + B_{13} + \varepsilon_{it}$$ Where:

$ParticipationRate_{it}$ = High or low savings participation rate in Census block group

B_1 = Indicator for neighborhood with high proportion of homeowners

B_2 = Indicator for neighborhood with high proportion of renters

B_3 = Indicator for neighborhood located in city

B_4 = Indicator for neighborhood located in town

B_5 = Indicator for neighborhood with high proportion of nonwhite residents

B_6 = Indicator for neighborhood with high proportion of white residents

B_7 = Indicator for neighborhood with high proportion of single family housing (up to 5 units)

B_8 = Indicator for neighborhood with low average household energy consumption

B_9 = Indicator for neighborhood with high average household energy consumption

B_{10} = Indicator for neighborhood with very high proportion of homes with electric heating fuel

B_{11} = Indicator for neighborhood with high proportion of homes with electric heating fuel

B_{12} = Indicator for neighborhood with high average energy burden

B_{13} = Indicator for neighborhood with high proportion of households lacking internet access

ε_{it} = Error term

Model Results and Interpretation

The results of the high and low savings models are presented in Table 1.

Table 1. Participation Model Results

Characteristic	High Savings Model Statistic	Low Savings Model Statistic
High proportion homeowners	0.324	0.770
High proportion renters	0.051	-0.135
Neighborhood in city	0.621*	2.820*
Neighborhood in town	0.358*	2.638*
High proportion nonwhite residents	0.682*	0.876*
High proportion white residents	-0.016	1.168*
High proportion single family housing [a]	0.463*	-0.107
Low average household energy consumption	-0.915*	0.709*
High average household energy consumption	0.459*	-0.960*
Very high proportion electric heating fuel	0.426*	-2.180*
High proportion electric heating fuel	0.117*	-0.500*
High average energy burden	0.197*	-2.546*
High proportion households without internet access	0.475*	0.022

*Statistically significant at 90% confidence level.
[a] Defined as homes with five units or fewer.

After identifying the key predictor variables (i.e., those statistically significant at a 90% confidence level), we determined the relative importance of each variable by considering its contribution to our understanding of the variation in participation rates between neighborhoods. We determined the relative importance of each predictor variable by calculating the percentage of total variation explained by each individual variable. We did separately for predictor variables with positive and negative coefficients.

The most important factors associated with participation in high savings programs are the proportion of nonwhite residents, being in a city, and a high proportion of households without internet access. These predictors all suggest that Duke Energy is reaching at least some disadvantaged populations through their current offerings. In addition, neighborhoods with single family or small multi-family housing units and very high proportions of households that heat with electric fuel achieve higher participation levels in high savings offerings. If a neighborhood has high per-household average energy consumption, this contributes to greater participation rates for high savings offerings, whereas neighborhoods with low per-household average energy consumption tend to have low participation rates in these offerings.

Table 2. Contribution of Neighborhood Characteristics to High Savings Participation Rate

Direction of Impact	Characteristic	Contribution to Explained Variation [a]
Positive	High proportion nonwhite residents	18%
	Neighborhood in city	16%
	High proportion households without internet access	13%
	High proportion single family housing [b]	12%
	High average household energy consumption	12%
	Very high proportion electric heating fuel	11%
	Neighborhood in town	9%
	High average energy burden	5%

Direction of Impact	Characteristic	Contribution to Explained Variation [a]
	High proportion electric heating fuel	3%
Negative	Low average household energy consumption	100%

a Contributions were calculated separately for characteristics with positive vs. negative influence. Contributions will add up to 100% per direction.

b Defined as homes with five units or fewer.

The most important factors associated with participation in low savings programs are both being in a city or town and having a high proportion of white or nonwhite residents. These results suggest that low savings offerings reach a very diverse range of customers, regardless of race and geographic location. Neighborhoods with low average per-household energy consumption have lower participation rates, whereas neighborhoods with high average per-household energy consumption have higher participation rates in offerings with low savings potential. Importantly, the most important negative predictor of neighborhood participation rates is energy burden. Those neighborhoods where residents have a high energy burden, on average, have lower participation rates in the low savings offerings.

Table 3. Contribution of Neighborhood Characteristics to Low Savings Participation Rate

Direction of Impact	Characteristic	Contribution to Explained Variation [a]
Positive	Neighborhood in city	34%
	Neighborhood in town	32%
	High proportion white residents	14%
	High proportion nonwhite residents	11%
	Low average household energy consumption	9%
Negative	High average energy burden	41%
	Very high proportion electric heating fuel	35%
	High average household energy consumption	16%
	High proportion electric heating fuel	8%

a Contributions were calculated separately for characteristics with positive vs. negative influence. Contributions will add up to 100% per direction.

Finally, to interpret the model results in light of our research focus on LMI customer participation, we assessed how each predictor variable that was both statistically and substantively significant corresponds with LMI status. This allows us to explain how the effect of sociodemographic, housing, and energy consumption characteristics combine with LMI status to increase or decrease participation in energy efficiency offerings. These results are presented in the main report.

Appendix C. Electric Bill Costs and Payments Detailed Methods

Data Request and Billing Data Preparation

The cost and payment analysis relied on data from multiple streams, provided separately for DEC and DEP. The data streams included the following:

- Customer bills
- Customer payments
- Accounts charged off
- Disconnections and reconnections[2]

All datasets covered the timeframe of March 1, 2017 through March 31, 2021, unless otherwise noted. The data timeframe was selected in coordination with Duke Energy based on data availability. The following customers were included in the initial data request:

- Participants in Duke Energy programs between 2013 and 2020 with accounts still active at any point between 2017 and 2020, residing in census block groups where 50% or more of households were LMI
- Nonparticipating customers were selected randomly from same Census block groups as participants to use as a point of comparison
- The analysis was limited to participants with moderate to high savings (at least 250 kWh in ex ante savings) to limit noise from low savings opportunities. Ex ante savings were calculated per customer as the total ex ante savings from all projects in the 2013 – 2020 timeframe.

We processed monthly DEC and DEP billing data including identifying customers on payment plans, calculating arrearage amounts, as well as organizing data in a format supportive of the analysis. Our analysis included program participants residing in census block groups with at least 50% of LMI customers who participated in Duke Energy efficiency programs between 2017 and March 2020. We further refined eligibility criteria to only include participants with anticipated savings of 250 kWh and higher. These choices were driven by both data availability and statistical modeling considerations. More specifically, we chose to include participants with savings over 250 kWh to ensure that bill impacts are detectable in the monthly billing data. Furthermore, we chose to exclude participants from March 2020 and onwards due to changes in customer billing processes, including moratorium on disconnections, as well as significant changes to customer energy usage patterns as a result of the COVID-19 pandemic, both of which are challenging to control for in the modeling process. Using the above criteria, we narrowed the subpopulation of participants to 105,327.

We performed the following cleaning steps on the participant data:

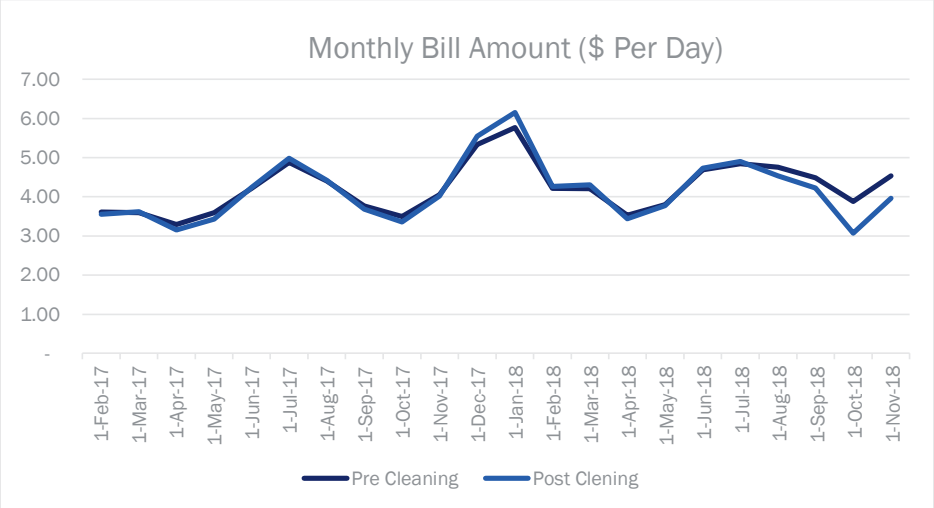
- **Duplicate records.** We explored duplicate and overlapping bill records and made adjustments to arrive at a single bill per period.
- **Extremely short or long bill periods.** We identified and dropped bill periods with a duration of zero days, a negative duration (i.e., start date is after end date), or a duration of more than 90 days.

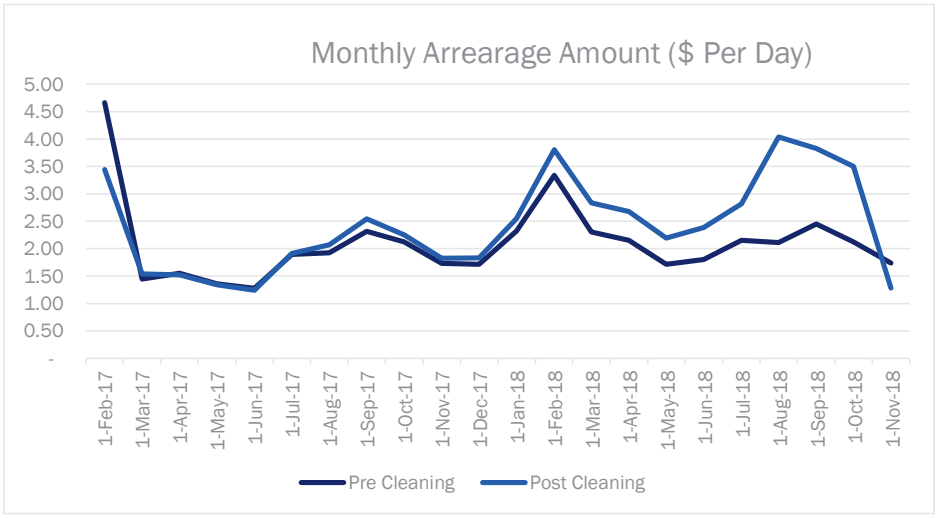
[2] This dataset only covered the period of July 2021 through October 2021 for DEP due to data limitations.

- **Missing and negative bill values.** We identified and dropped bill periods with blank or negative bill values.
- **Extremely high bills**. We checked for and removed bill periods with extremely large bills.
- **Customers on payment plan.** We identified and removed customers on a payment plan.
- **Inadequate billing history before or after program participation**. We removed participants with insufficient (less than 9 months) of billing history pre- and post-participation.
- **Deadbanding post-period.** We excluded first six months following program participation to allow participants to start accruing any bill savings as a result of the program participation

The above data cleaning steps resulted in 17,529 participants retained in the analysis. Most of the dropped accounts (85%) were due to insufficient pre- or post-period data following deadbanding of the post-participation period by six months. We conducted an assessment of the cleaned participant data against all participant data on data points of interest, namely monthly bills and arrearages. Figure 11 compares participant billing and arrearage data before and after cleaning.

Figure 11. Participant Billing Data Comparison





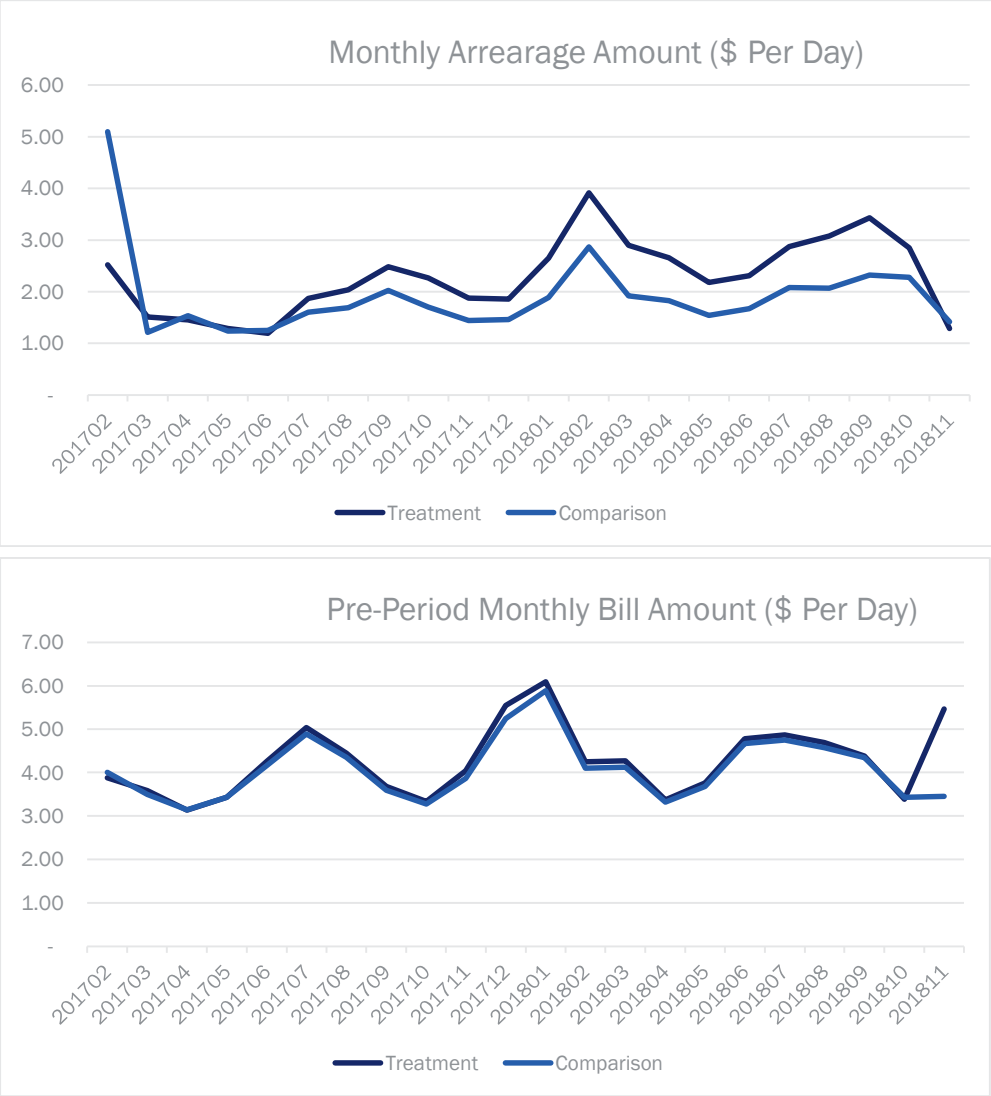
Comparison Group Selection and Equivalency Analysis

A key challenge for estimating bill impacts via a statistical analysis is the identification of an appropriate comparison group to represent a baseline for what participant bills would have been in the absence of program participation. We consider two main factors in the design of a comparison group. A comparison group must (1) have similar bill patterns (compared to participants) before participation (i.e., pre-participation period) and (2) effectively address self-selection bias (the correlation between the propensity to participate in a program and bill amounts). In an ideal experimental design, a randomized control trial (RCT) would be used, and the comparison group would be equivalent to the treatment group in all aspects, save for the treatment being evaluated (in this case, participation in the Weatherization Program). When an RCT is not feasible, we use a quasi-experimental design with a comparison group. For this analysis, we chose to comprise a comparison group from a sample of nonparticipants drawn from the same census block groups as participants. We did that to ensure that nonparticipants are as similar to participants as possible. Selecting nonparticipants from the same census block groups allows us to effectively minimize differences in bills associated with geographic

proximity and therefore differences in weather, housing stock, and economic markers, such as income. Following receipt of the nonparticipant data, we further narrowed our eligible comparison group by performing a matching analysis using distance matching algorithms. We used customer monthly bills to determine closest and best matches. We matched one-to-one seeking to identify one matched non-participant for each participant. Our matching algorithm pursued matching with replacement, wherein we allowed a single non-participant to act as a match to multiple participants. We performed matching in stages, wherein we first matched participants within each state and jurisdiction and following which steadily expanded distance criteria to optimize the number of participants with matches.

Following the matching process, we reviewed matches to ascertain equivalency. We reviewed monthly bills as well as arrearages as part of the equivalency analysis. We performed equivalency assessment by jurisdiction. Following the equivalency assessment, we cleaned the nonparticipant data in a similar fashion to the participant data and reran equivalency analysis. Figure 12 shows equivalency results between participants and matched nonparticipants.

Figure 12. Equivalency Results



We were able to find strong matches for a total of 14,640 participants. We proceeded with developing models for that subpopulation of participants.

Weather Data Preparation

To include weather patterns in our model, we used daily weather data from numerous weather stations across the DEC and DEP service territory, utilizing the site closest to each account's geographic location. By using multiple sites, we increased the accuracy of the weather data being associated with each account. We obtained these data from the National Climatic Data Center (NCDC).

The daily data are based on hourly average temperature readings from each day. We calculated CDD and HDD for each day (in the analysis based on average daily temperatures, using the same formula used in weather

forecasting).[3] We merged daily weather data into the billing dataset so that each billing period captures the HDD and CDD for each day within that billing period (including start and end dates).[4]

Model Specification

To estimate bill impacts, Opinion Dynamics specified a linear fixed effects model in a difference in difference approach that teases out bill impacts by modeling before and after treatment for the treatment group and the same time period for the comparison group. The comparison group controls for non-program changes (exogenous changes) over the analysis period. The fixed effect for the model is set at the account level, which allows us to control for all household factors that do not vary over time. In the process of determining the appropriate model for the analysis, we tested a multitude of possibilities. Equation 2 contains the final model specification.

Equation 2. Model Specification

$$Bill_{it} = B_1 HDD_{it} + B_2 CDD_{it} + PostTreat_{it} + B_3 HDD_{it} * PostTreat_{it} + B_4 CDD_{it} * PostTreat_{it} + PostComp_{it} + B_5 HDD_{it} * PostComp_{it} + B_6 CDD_{it} * PostComp_{it} + B_{7-4}\ MonthDummies_t\ + B_h + \varepsilon_{it}$$

Where:

$Bill_{it}$ = Average daily bill (in $) for the billing period

$Post$ = Indicator in post-installation period (coded "0" in the pre-participation period, coded "1" in post-installation period)

HDD = Average daily heating degree days from NCDC

CDD = Average daily cooling degree days from NCDC

Treat = Treatment group

Comp = Comparison group

B_h = Average household-specific constant

ε_{it} = Error term

Several variations of this model were specified, including LMI quartiles and percentiles, and savings quartiles as distinct terms on the models, allowing to determine bill impacts by subgroups.

[3] A "degree-day" is a unit of measure for recording how hot or how cold it has been over a 24-hour period. The number of degree-days applied to any particular day of the week is determined by calculating the mean temperature for the day and then comparing the mean temperature to a base value of 65 (HDD) and 75 (CDD) degrees F. (The "mean" temperature is calculated by adding together the high for the day and the low for the day, and then dividing the result by 2.) If the mean temperature for the day is 5 degrees higher than 75, then there have been 5 cooling degree-days. On the other hand, if the weather has been cool, and the mean temperature is, say, 55 degrees, then there have been 10 heating degree-days (65 minus 55). "Degree Days," National Weather Service, https://www.weather.gov/ffc/degdays.

[4] Daily weather data are merged based on the given dates of the billing period. Assigning weather this way provides a more accurate representation of the weather experienced during the billing period than does using weather for the calendar month of the bill.

Appendix D. Customer Survey Detailed Results

This section provides additional data and insights from the participant and nonparticipant surveys.

Demographic Characteristics of Respondents

Of survey respondents, 64% of nonparticipants and 59% of participants are low- or moderate-income (Table 4) based on their reported household income in 2021, relative to the size of their household and the area median income. Although the focus of our survey efforts was on understanding the LMI customer experience, the participation of non-LMI households in the survey allowed us to make comparisons between LMI and non-LMI households to better understand the unique participation experiences, barriers, and motivations of Duke Energy's LMI households[5].

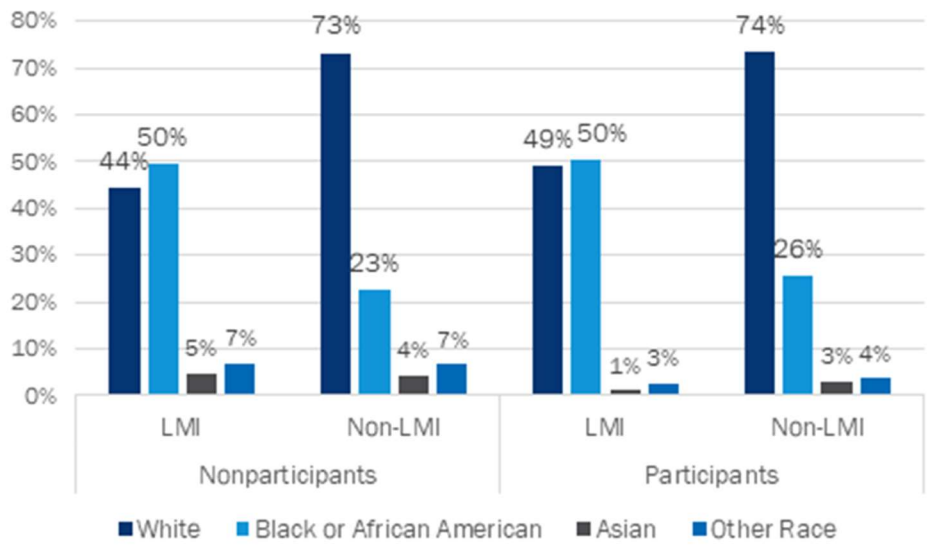
Table 4. LMI Status

LMI Status	Nonparticipants (n=483)	Participants (n=362)
Non-LMI	36%	41%
LMI	64%	59%
Low income	*40%*	*37%*
Moderate income	*23%*	*22%*

Race is related to LMI status, but not to participation status. LMI participants and nonparticipants are significantly more likely to report their race as Black or African American than their respective non-LMI counterparts (Figure 13). Non-LMI participants and nonparticipants are significantly more likely to report their race as White than their respective LMI counterparts. However, nonwhite households are similarly likely to be participants or nonparticipants

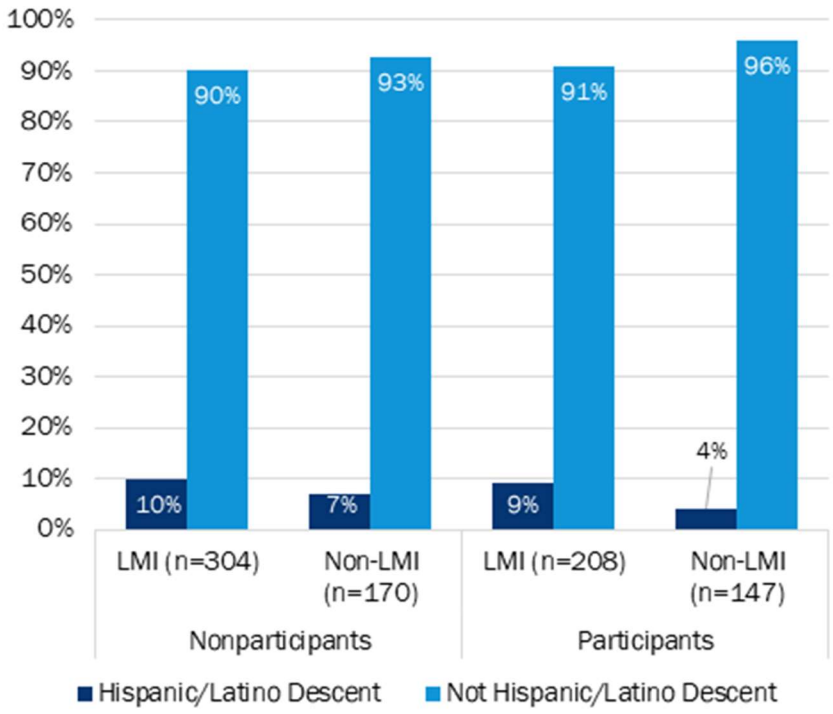
[5] 25% of nonparticipants (n=483) and 32% of participants (n=362) did not report their income and are excluded from the results reported in this section.

Figure 13. Race



Similarly, a greater proportion of LMI than non-LMI households report that they are of Hispanic, Latino, or Spanish descent than non-LMI households. This is true within both the participant and nonparticipant groups (Figure 14).

Figure 14. Ethnicity



Of all groups, LMI nonparticipants are most likely to report a language other than English as their first language, suggesting that some of these customers may face language barriers in accessing program materials and processes. While four to five percent of all other groups say that their first language is not English, this figure doubles (10%) for LMI nonparticipants (Table 5). Spanish is the most common first language, after English, among LMI respondents.

Table 5. First Language

First Language	Nonparticipants		Participants	
	LMI (n=303)	Non-LMI (n=176)	LMI (n=210)	Non-LMI (n=149)
English*	90%	96%	95%	95%
Not English*	10%	5%	5%	5%
Spanish	*7%*	*2%*	*3%*	*2%*
Other	*3%*	*1%*	*1%*	*2%*

* Statistically significant difference between nonparticipant groups at a 90% confidence level

LMI participants have significantly more people living in their home than non-LMI participants (3 vs. 2 respectively). Likewise, LMI nonparticipants have significantly more people living in their home than non-LMI nonparticipants (3 vs. 2 respectively). LMI nonparticipants and LMI participants are significantly more likely to have children in their home than their respective non-LMI counterparts (Table 6).

Table 6. Age Groups in Household

Age Groups in Household†	Nonparticipants		Participants	
	LMI (n=307)	Non-LMI (n=176)	LMI (n=213)	Non-LMI (n=149)
Children in household*§	43%	21%	43%	25%
Adults in households	87%	92%	78%	80%
Seniors in household	16%	13%	32%	30%

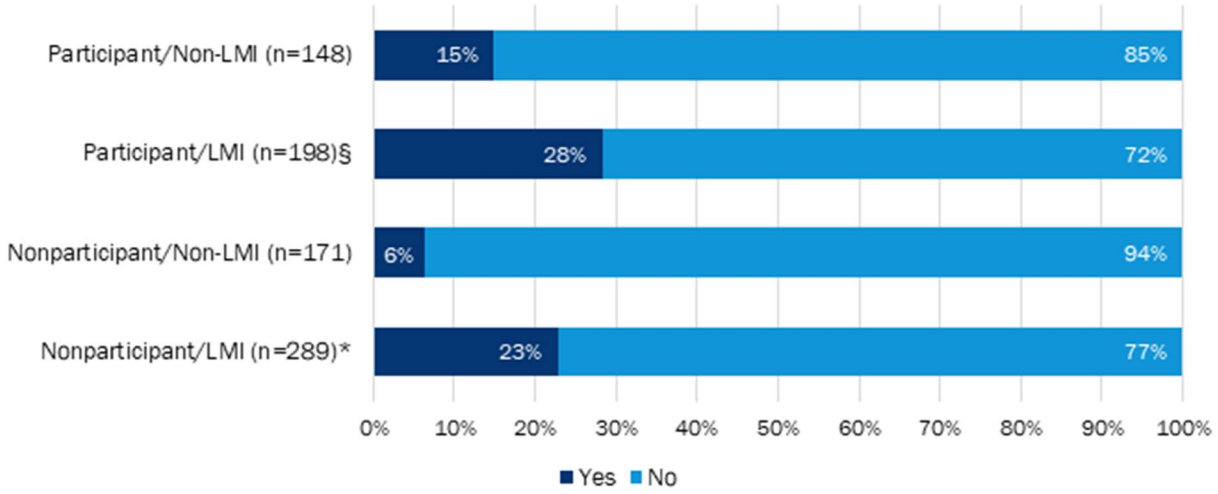
* Statistically significant difference between nonparticipant groups at a 90% confidence level

§ Statistically significant difference between participant groups at a 90% confidence level

† Values will not sum to 100% as multiple responses were permitted

LMI nonparticipants and LMI participants are significantly more likely than non-LMI households within each group to have someone in the household with conditions or disabilities that require special medical equipment, more heating and/or cooling, or higher air quality (Table 7). This suggests that LMI households are particularly likely to benefit from the non-energy impacts (NEIs) associated with participation in an energy efficiency program.

Table 7. Member of Home with Conditions or Disabilities that Require Special Medical Equipment, More Heating and/or Cooling, or Higher Air Quality



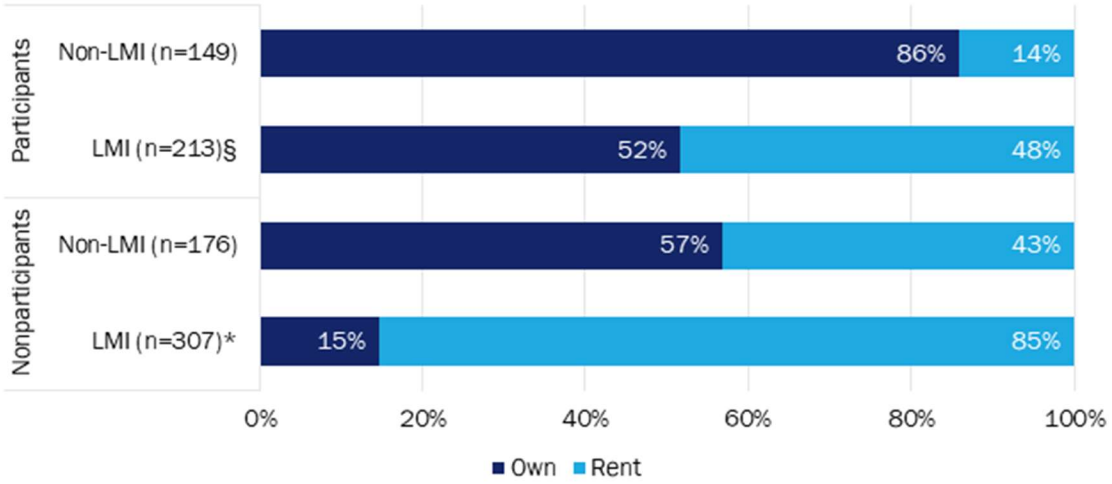
* Statistically significant difference between nonparticipant groups at a 90% confidence level

§ Statistically significant difference between participant groups at a 90% confidence level

Housing Characteristics of Respondents

LMI participants and nonparticipants are significantly more likely than non-LMI participants and nonparticipants to rent their home (Figure 15). Of all groups, LMI nonparticipants are by far most likely to be renters, while non-LMI participants are by far most likely to be homeowners.

Figure 15. Owner/Renter Status



* Statistically significant difference between nonparticipant groups at a 90% confidence level

§ Statistically significant difference between participant groups at a 90% confidence level

LMI customers tend to live in different types of housing than non-LMI customers, as do nonparticipants compared to participants. These differences in housing stock are related to owner/renter status as discussed above and affect the program eligibility. LMI participants and nonparticipants are significantly more likely than their non-LMI counterparts to live in a mobile/manufactured/trailer home or multifamily residence. Across participants and nonparticipants, non-LMI households are more likely than LMI households to live in a single family detached home (Table 8).

Table 8. Housing Type

Type of Home	Nonparticipants		Participants	
	LMI (n=284)	Non-LMI (n=173)	LMI (n=208)	Non-LMI (n=149)
Single family (detached)*§	28%	53%	64%	81%
Single family (attached)	14%	15%	8%	5%
Multifamily*§	54%	32%	20%	11%
*A duplex or two family house**	*8%*	*2%*	*3%*	*1%*
*A three-unit apartment/condo**	*6%*	*2%*	*1%*	*1%*
A four-unit apartment/condo§*	*10%*	*1%*	*6%*	*1%*
A five-unit or more apartment/condo	*30%*	*27%*	*11%*	*8%*
A mobile, manufactured, or trailer home*§	4%	1%	7%	2%
Other	0%	0%	1%	1%

* Statistically significant difference between nonparticipant groups at a 90% confidence level

§ Statistically significant difference between participant groups at a 90% confidence level

A higher proportion of LMI households than non-LMI households heat primarily with electric fuel (Table 9). Heating fuel is much more strongly associated with LMI status than with participation status and is likely driven by differences in housing type. LMI customers are more likely to live in multifamily homes, which are more likely than single-family homes to use electricity as the heating fuel source.

Table 9. Primary Heating Fuel

Primary Heating Fuel	Nonparticipants		Participants	
	LMI (n=302)	Non-LMI (n=172)	LMI (n=212)	Non-LMI (n=148)
Electric*	78%	66%	72%	65%
Natural gas*§	22%	31%	24%	33%
Propane	0%	2%	3%	1%
Other	0%	1%	1%	1%

* Statistically significant difference between nonparticipant groups at a 90% confidence level

§ Statistically significant difference between participant groups at a 90% confidence level

LMI participants and nonparticipants are less likely to have central air conditioning than their non-LMI counterparts. LMI households in both groups are more likely to rely on window units alone compared to their non-LMI households (Table 10).

Table 10. Air Conditioning in Home

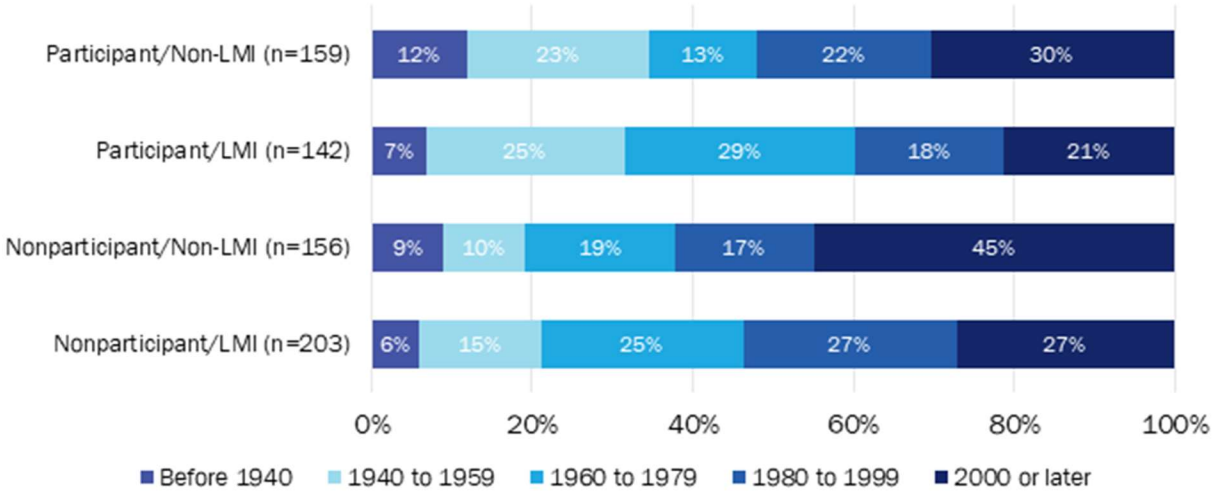
Air Conditioning	Nonparticipants		Participants	
	LMI (n=307)	Non-LMI (n=176)	LMI (n=213)	Non-LMI (n=149)
Central air conditioning*§	83%	94%	81%	93%
Window units*§	11%	1%	12%	2%
Both central air conditioning and window units	7%	5%	5%	4%
No air conditioning	3%	1%	2%	1%

* Statistically significant difference between nonparticipant groups at a 90% confidence level

§ Statistically significant difference between participant groups at a 90% confidence level

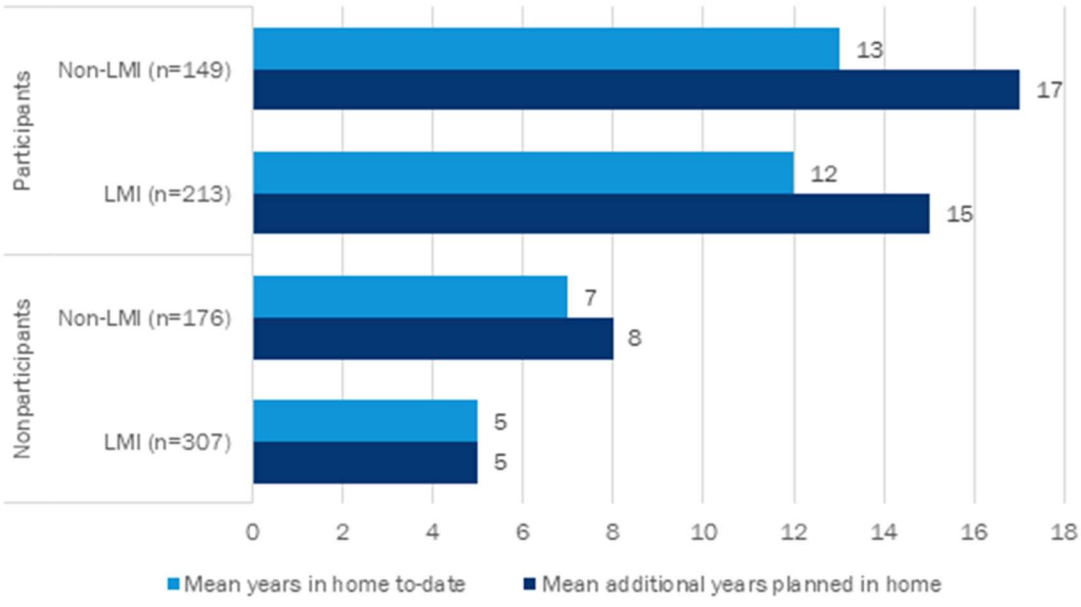
LMI households in both the participant and nonparticipant groups reside in older homes on average compared to their non-LMI counterparts. Approximately half (52%) of non-LMI participants report their home was built after 1980, compared to 39% of LMI participants. Similarly, 62% of non-LMI nonparticipants' homes were built after 1980, compared to 54% of LMI nonparticipants. In addition, nonparticipants have newer homes on average than participants, with a higher percentage of LMI and non-LMI nonparticipants' homes being built after 1980 compared to LMI and non-LMI participants' homes, respectively (Figure 16).

Figure 16. Year Home Constructed



The length of time that customers have lived in their homes and their future intentions is more related to participation than LMI status. Participants, both LMI and non-LMI, have lived in their homes and plan to continue to live in them longer than nonparticipants (Figure 17). LMI participants and nonparticipants have spent slightly fewer years in their homes than their non-LMI counterparts, and similarly intend to live in their homes for slightly fewer years.

Figure 17. Actual and Planned Years in Home



Additional Insights and Analysis

In this section, we present additional insights and analysis not included in the main report. Where available, we include quotes from in-depth interview respondents that add depth and nuance to the survey results.

Program Awareness

All survey respondents, regardless of LMI and participation status, are most familiar with Duke Energy's free home energy assessment. After home assessments, survey respondents are most familiar with Duke's online rebates for energy efficient equipment and discounts on lightbulbs in retail stores. LMI participants and nonparticipants are significantly less familiar with all of Duke Energy's energy efficiency program offerings than their non-LMI counterparts except for the recycling program for old refrigerators and freezers (Table 11). Relatively low familiarity with Duke Energy's energy efficiency program offerings amongst nonparticipants and participants alike suggests the need for continued outreach. It also presents the opportunity for cross promotion of additional offerings customers may qualify for during the participation process.

Table 11. Average Participant and Nonparticipant Familiarity with Specific Program Offerings

Program/Offering	Participant Mean Familiarity		Nonparticipant Mean Familiarity	
	LMI (n=213)	Non-LMI (n=149)	LMI (n=307)	Non-LMI (n=176)
Free home energy assessment with recommendations on upgrades to make your home more efficient§*	2.6	3.1	1.5	2.0
Online rebates on energy efficient equipment such as light bulbs, faucet aerators, and low-flow showerheads§*	2.5	3.0	1.5	1.8
Discounts on LED light bulbs in local retail stores§*	2.4	2.9	1.5	1.8
Online rebates on smart thermostats§*	2.2	3.1	1.5	1.8
No-cost energy efficient equipment, insulation, and/or heating upgrades for income qualifying customers§*	1.8	2.1	1.3	1.5
Online rebates on energy efficient heating and cooling systems§*	1.9	2.3	1.4	1.7
Rebates on insulation and heating and cooling systems installed through a participating contractor§*	1.8	2.4	1.4	1.5
Recycling program for old refrigerators and freezers	1.6	1.5	1.2	1.3

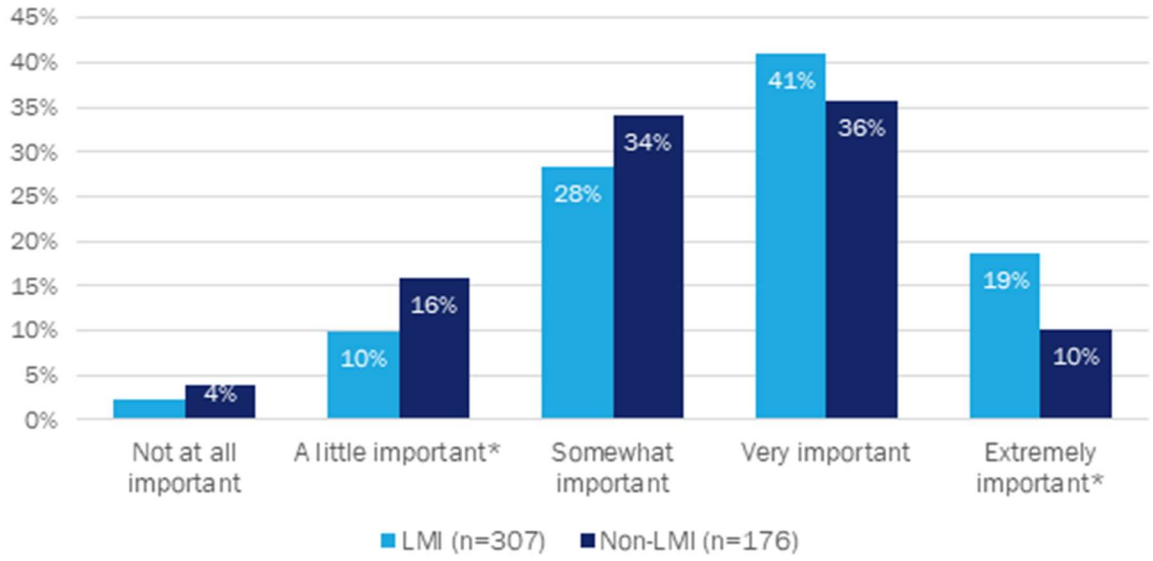
* Statistically significant difference between nonparticipant groups at a 90% confidence level

§ Statistically significant difference between participant groups at a 90% confidence level

Energy Efficiency Attitudes

LMI nonparticipants are more likely than non-LMI nonparticipants to say doing their part to make the Carolinas more efficient is "extremely important" (Figure 18). Non-LMI nonparticipants, in contrast, are more likely to say that doing their part is only "a little important" compared to their LMI counterparts, suggesting that LMI nonparticipants are more motivated by their sense of duty to their state than non-LMI nonparticipants.

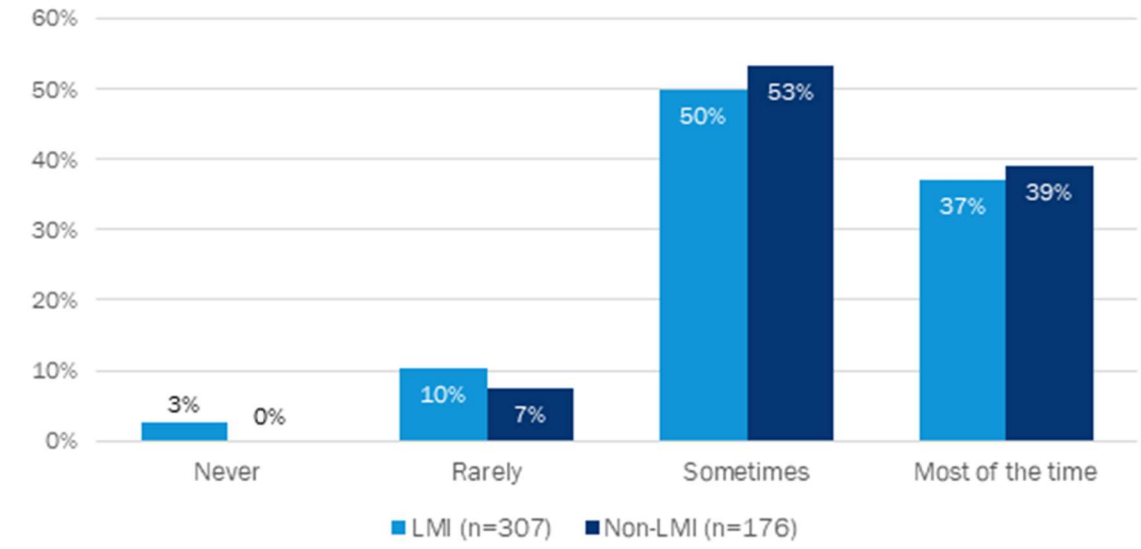
Figure 18. Nonparticipant Importance of Doing One's Part to Make the Carolinas More Energy Efficient



* Statistically significant difference between groups at a 90% confidence level

LMI nonparticipants report making a similar amount of effort as non-LMI nonparticipants to live in a way that reduces their energy usage (Figure 19).

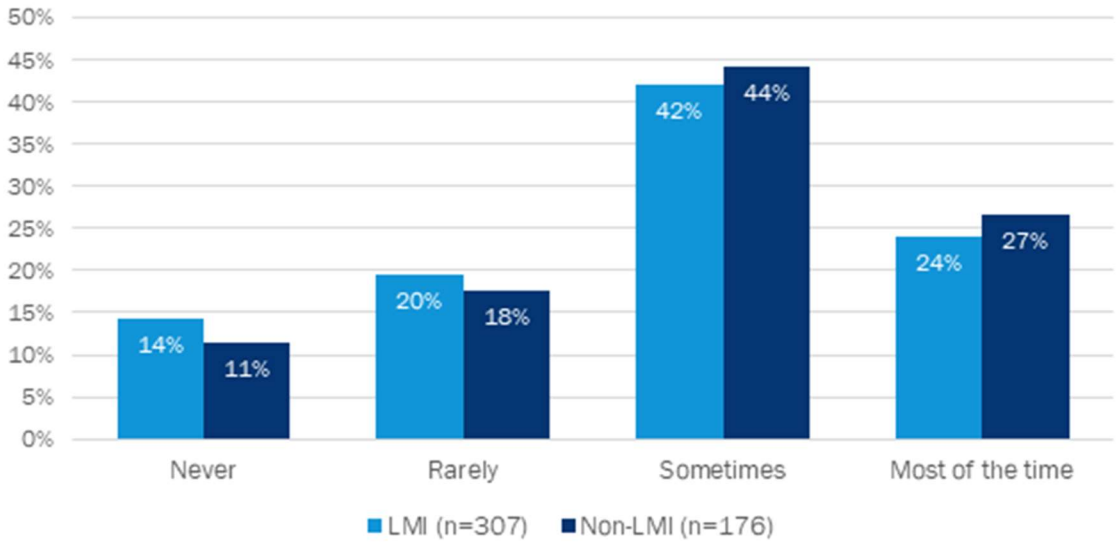
Figure 19. How often Nonparticipants Make an Effort to Live in Ways that Reduce their Home Energy Usage



Note: Results based on nonparticipant web survey data

LMI and non-LMI nonparticipants also did not significantly differ in how often the energy usage of appliances affects their purchasing decisions (Figure 20).

Figure 20. Influence of Appliance Energy Usage on Nonparticipant Purchasing Decisions



These findings highlight that how often nonparticipants actively live in a way or purchase appliances to reduce their energy usage does not vary by their income, suggesting that non-LMI customers do not actively live in a more energy conscious way than LMI customers. Additionally, LMI nonparticipants place more importance on the need to play their part in Carolina's larger efficiency goals than their non-LMI counterparts.

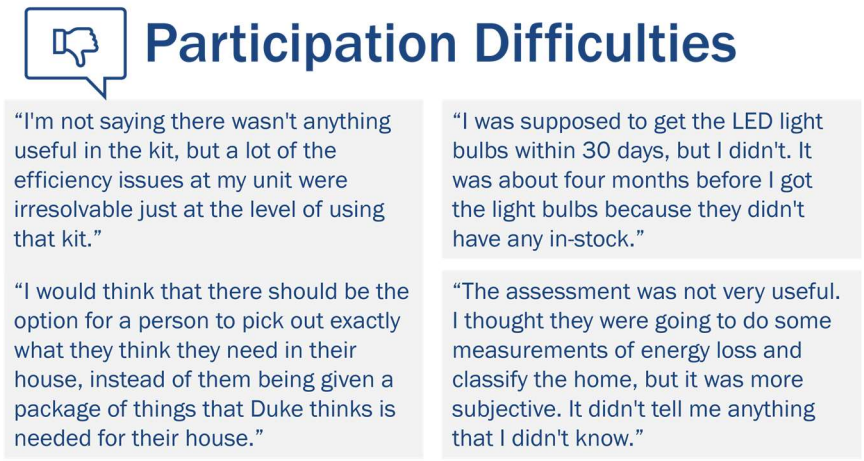
Participation Experience

On average, surveyed participants reported a positive experience participating in Duke Energy's programs and felt that participating benefited them, and these effects were stronger for LMI participants than for their non-LMI counterparts. LMI participants are significantly more satisfied with their experience participating in Duke Energy's energy efficiency programs than non-LMI participants (8.0 vs. 7.6 on a scale of 0, "extremely dissatisfied" to 10, "extremely satisfied"). This satisfaction was echoed by interviewed participants (Figure 21).

Figure 21. Quotes on Positive Participation Experiences from Participant Interviews

Interviewed participants also shared suggestions for improving Duke Energy's programs (Figure 22).

Figure 22. Quotes on Suggested Improvements from Participant Interviews



Average satisfaction was similar across different program offerings (Table 12), ranging from 7.5 to 8.0. The most common reasons for low satisfaction are lack of bill savings and dissatisfaction with the equipment received.

Table 12. Participant Satisfaction with Duke Energy Programs

Program	Average Satisfaction Score*
Free LED CFL Program (n=169)	8.0
Online Savings Store (n=85)	7.5

Program	Average Satisfaction Score*
Save Energy in Water (n=76)	7.8
Residential Energy Assessments (n=61)	7.9
K12 Program (n=59)	8.0
Single Family Water Measures (n=55)	7.6

Note: Results based on participant web survey data for programs where n>50

*Results are not broken down by LMI status to avoid comparison groups with n<50.

LMI and non-LMI participants did not significantly differ in how satisfied they were with their communications with Duke Energy and program staff, averaging 7.9 and 7.5 respectively on a scale of 0, "extremely dissatisfied" to 10, "extremely satisfied." About 17% of participants indicated they never communicated with a Duke Energy representative or member of program staff during their participation.

Appendix E. In-Depth Participant Interviews

Demographic and Housing Characteristics of Respondents

Table 13 presents the number of IDI respondents in each income bucket: low-income, moderate-income, and non-LMI. Most respondents met LMI criteria.

Table 13. IDI LMI Status

LMI Status	IDI Respondents (n=37)*
Non-LMI	16
LMI	21
Low-income	13
Moderate-income	8

* Three respondents did not know or preferred not to report their income

Table 14 presents the number of IDI respondents that say their first language is or is not English.

Table 14. IDI First Language

First Language	IDI Respondents (n=40)
English	37
Other language	3

Table 15 presents the number of IDI respondents that do or do not have children in the home.

Table 15. IDI Children in Household

Presence of Children in Household	IDI Respondents (n=40)
Children in household	14
No children in household	26

Table 16 presents the number of IDI respondents by housing type.

Table 16. IDI Housing Type

Housing Type	IDI Respondents (n=40)
Single family	33
Multifamily	7
A five-unit or more apartment/condo	6
A four-unit apartment/condo	1

Table 17 presents the number of IDI respondents who own or rent their home.

Table 17. IDI Housing Ownership Status

Housing Ownership Status	IDI Respondents (n=40)
Own	31
Rent	9

Table 18 presents respondents' approximation of when their homes were built.

Table 18. IDI Year Home Built

Year Home Built	IDI Respondents (n=33)*
1920 - 1939	5
1940 - 1959	5
1960 - 1979	7
1980 - 1999	7
2000 or after	7

* Seven respondents did not know or preferred not to report when their home was built

Table 19 presents how long respondents said they have lived in their home at the time of the survey.

Table 19. IDI Time at Address/Tenure

Time at Address	IDI Respondents (n=39)*
Less than 5 years	14
5 to 9 years	9
10 to 19 years	6
20 to 39 years	7
40 years or more	3

* One respondent did not know or preferred not to report their time at their address

Table 20 presents the type of cooling equipment respondents report having in their home.

Table 20. IDI Cooling Equipment

Air Conditioning	IDI Respondents (n=40) †
No air conditioning	2
Central air conditioning	36
Window unit(s)	3

† Values will not sum to n=40 as multiple responses were permitted

Participant Vignettes

A selection of participant experiences are summarized in the attached vignettes. All participants featured in the vignettes meet LMI criteria based on reported income and household size.

Duke LMI Participant Vignettes FINAL 2022-

For more information, please contact:

Danielle Fulmer
Principal Consultant

617-492-1400 tel
dfullmer@opiniondynamics.com

1000 Winter Street
Waltham, MA 02451