THE UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL

# *How to look forward without looking back:*

# *Innovative approaches to forecasting green finance program demand*


**AUTHORS**

**Christine E. Boyle**
Environmental Finance Center, School of Government
Knapp-Sanders Building, CB #3330
University of North Carolina at Chapel Hill
Chapel Hill, NC 27599
(919) 966-4199
cboyle@sog.unc.edu

**Michael Chasnow**
Environmental Finance Center, School of Government
Knapp-Sanders Building, CB #3330
University of North Carolina at Chapel Hill
Chapel Hill, NC 27599
(919) 843-4954
Michael_Chasnow@kenan-flagler.unc.edu

**Jeff Hughes**
Environmental Finance Center, School of Government
Knapp-Sanders Building, CB #3330
University of North Carolina at Chapel Hill
Chapel Hill, NC 27599
(919) 843-4956
jhughes@sog.unc.edu


**FEBRUARY 2011**

UNC ENVIRONMENTAL FINANCE CENTER

**ABSTRACT**

Given the low number of customer sales uptake records for energy efficiency and renewable energy (EERE) loan products, traditional methods of demand or market analysis are not possible for emerging residential, commercial and industrial EERE loan sectors. In this paper we ask, given limited historic market data for EERE loans, how can cities, counties, banks and states assess potential markets for EERE loan uptake? To answer this question, we develop a new methodology for assessing potential *residential* demand for EERE financing products, and use the CharlestonSAVES*TM* program to demonstrate how the *Traffic Light Demand Rating System* market analysis methodology works.

## I. INTRODUCTION

Residential buildings in the United States account for about 20% of greenhouse gas emissions (EPA 2010) and roughly 20% of the nation's total energy consumption (EIA 2008). Meeting a national goal of reducing greenhouse gas emissions by more than 80% by 2050 will require widespread coordinated effort to reduce the energy use of our existing building stock, and increased regulatory commitment to mandate energy efficiency standards in new construction. One key ingredient in upgrading existing building stock with energy efficiency retrofits is devising strategies to enable building owners to pay for the high upfront costs associated with energy efficiency and renewable energy (EERE) construction. Financing tools aimed at EERE projects range from rebates, grants, and loan products, and are currently growing in size and number. However, a current gap in the development of wide-scale EERE loan uptake is the identification of key groups of residential customers with demand for EERE finance products. Currently, there is no strategic approach for effectively targeting and marketing EERE programs to the customers most likely to participate in, and successfully repay, EERE loans.

In this paper we introduce a methodology wherein we develop alternate measures – categorized as 'determinants of demand' – to forecast energy efficiency loan adoption, using data and information from county parcel-level data and nationally available energy efficiency data repositories. These data sets are used to estimate future demand for EERE finance programs, based on housing, industry and property-level characteristics that correlate with large room for energy efficiency gains. These early stage market analyses provide critical planning tools for the program sales force, determining programmatic scale, and as a roadmap for targeted marketing campaigns. To date, market analysis of

EERE finance products remains coarse and highly generalized, and this paper aims to fill this gap in the green development finance arena.

We develop two separate market analysis processes, one for measuring potential residential demand for EERE financing products, and one for measuring industrial demand for EERE financing products. We use market analysis for the City of Charleston's CharlestonSAVES*TM* program, which focuses on the residential sector, to demonstrate this market analysis methodology.

This methodology is innovative in several ways. First, we base EERE loan uptake on determinants of demand specific to the housing stock, industrial portfolio and other economic characteristics of the households and businesses in the study area. Speculation on the scale and scope of demand for energy efficiency upgrades is often based on aggregate measures of energy usage and economic activity. In the analysis, we drill down to individual households and businesses to measure and identify specific locales with large potential demand for EERE loans. Next, this methodology is scalable for various market sizes – from city to county to state – and uses publicly available data to tailor the analysis to the region or area. Finally, we cross tabulate parcel-level housing and industry data with energy efficiency measures, specific to the parcel-level characteristics. This spatial matching with economic and energy efficiency characteristics is an innovation within the demand study space.

This paper is organized as follows. In the next section we provide background information on development to date of market demand methodologies for green energy finance programs. Next, we introduce our case study location, the City of Charleston, South

Carolina, and the data used for analysis. In the next section, we describe *Traffic Light Demand Rating System* methodology for utilizing publically available data to assess demand for EERE finance programs. This methodology was developed by the Environmental Finance Center and commissioned by Abundant Power in support of the CharlestonSAVES$^{TM}$ program. Following this, we present findings from the *CharlestonSAVES$^{TM}$ Demand Analysis*. Lastly, we discuss future directions for EERE financing demand studies.

## II. BACKGROUND

Loan product demand analyses typically measure potential loan uptake either by using historical data on comparable products, or by conducting a survey to estimate customer uptake rates at various price points. As energy efficiency loan programs remain in early stages of development and have few customer sales uptake records by which to forecast potential demand, traditional methods of demand or market analysis are not possible for emerging residential, commercial and industrial energy efficiency and renewable energy (EERE) loan sectors.

Recent reports of lessons learned in first generation household energy efficiency improvement programs emphasize that "time spent studying the target population is important" (Fuller 2010 page 2) but, it remains unclear how programs should first identify target populations for such programs. In simple terms, what characteristics comprise a potential energy efficiency upgrade customer? In addition, very little attention on the relationship between target customers and EERE finance products (e.g., loans, rebates, incentive programs).

Current research into marketing EERE lending programs focuses on strategies for promoting EERE lending products and reaching the general population in a given jurisdiction. Our demand analysis methodology enables EERE lending program administrators to use residential or commercial building characteristics (and credit history through utility bill repayment) to understand and measure demand. This allows administrators to create actionable program rollout strategies at the block, zip code or county level. Existing research identifies strategies to improve marketing efforts, and our methodology adds to this effort by enabling program administrators to better target locations for EERE program rollouts, which allows for further customization of marketing efforts (i.e., the two research strands complement one another).

## III. CASE STUDY: CITY OF CHARLESTON'S CHARLESTONSAVES™ PROGRAM

The CharlestonSAVES*TM* Program (the Program) in the City of Charleston, South Carolina is a Municipal Energy Efficiency Program designed to stimulate green collar jobs while enabling the City of Charleston to promote sustainable and verifiable energy savings to individuals, and commercial and institutional entities. Given the wide geographical space and diverse municipal population of Charleston, Phase 1 of the Program will target residential properties with energy efficiency project loans.

This Demand Analysis uses secondary data on the City of Charleston's residential properties to identify geographic areas and property types that are likely to finance an energy efficiency upgrade via the CharlestonSAVES*TM* loan program. By identifying target locations and property-types within the residential sector, the Demand Analysis will assist in the development of a strategic and cost-efficient marketing campaign.

Analysis of demand for residential energy efficiency project loans would typically measure potential loan uptake either by using historical data on comparable programs or by conducting a survey to estimate customer uptake rates at various price points. Energy efficiency loan programs however, remain in early stages of development. Therefore this analysis relies on alternate measures categorized as 'determinants of demand' for energy efficiency loan adoption, using data and information from county parcel-level data and nationally available energy efficiency data repositories. These data sets are used to estimate future demand for the Program, based on housing and property-level characteristics. This analysis forecasts demand for energy efficiency loans for residential homeowners based on a unique set of demand indicators described in this report.

## IV. DATA

This analysis draws from the following data sources:

- Charleston County Auditor (2010) Parcel-level property data for City of Charleston;
- Energy Information Administration (2005) Office of Energy Markets and End Use, Forms EIA-457 A-G of the "2005 Residential Energy Consumption Survey";
- LEED for Homes Rating System, Version 2008;
- US Census Bureau (2000) *Decennial Census*. Accessed at: www.census.gov; and
- US Department of Energy (2010) *Home Energy Saver calculator,* Environmental Energy Technologies Division, Lawrence Berkeley National Laboratory.

**Figure 1 City of Charleston Housing and Energy Use Profile, Fiscal Year 2009-10**

Residential Housing and Energy Profile

City of Charleston[a]

Fiscal Year 2009-10

*Zip codes with fewer than 500 residential parcels are excluded*

| "ZIP CODE" DEMOGRAPHICS (CENSUS 2000 ZCTAs) | | | | RESIDENTIAL[b] HOUSING CHARACTERISTICS | | | |
|---|---|---|---|---|---|---|---|
| Zip Code | Median HHLD Income | % Families Below Poverty Line | % of Zip Code's Housing that are Rented | Average fair market housing value | Number of residential parcels | Average housing area (square feet) | Average build year |
| 29401 | 36,671 | 18% | 47% | 902,869 | 1,469 | 2,964 | PRE-1900 |
| 29403 | 17,843 | 37% | 57% | 273,200 | 2,673 | 1,744 | 1932 |
| 29405 | 23,200 | 30% | 47% | 82,351 | 4,185 | 1,311 | 1956 |
| 29406 | 32,127 | 19% | 46% | 106,947 | 3,281 | 1,451 | 1981 |
| 29407 | 37,436 | 13% | 41% | 206,722 | 8,101 | 1,842 | 1965 |
| 29412 | 45,762 | 9% | 26% | 240,861 | 10,071 | 1,785 | 1977 |
| 29414 | 48,251 | 7% | 33% | 181,487 | 8,062 | 1,893 | 1988 |
| 29418 | 35,424 | 12% | 43% | 120,779 | 2,484 | 1,468 | 1981 |
| 29420 | 46,366 | 12% | 25% | 108,585 | 1,261 | 1,501 | 1976 |
| 29449 | 32,958 | 20% | 11% | 177,634 | 1,930 | 1,754 | 1981 |
| 29451 | 75,847 | 3% | 10% | 1,089,866 | 1,415 | 2,551 | 1982 |
| 29455 | 40,175 | 12% | 8% | 619,638 | 5,550 | 2,152 | 1989 |
| 29464 | 57,014 | 6% | 28% | 347,119 | 11,389 | 2,213 | 1984 |
| 29466 | 67,492 | 6% | 12% | 304,132 | 7,825 | 2,497 | 1999 |

**RESIDENTIAL HOUSING ENERGY CHARACTERISTICS**

| | FUEL SOURCE | | | HEATING-COOLING SYSTEM | | | |
|---|---|---|---|---|---|---|---|
| Zip Code | % using electricity as primary fuel | % using gas as primary fuel | % using oil as primary fuel | % forced-duct | % forced - no duct | % heat pump | % other[c] |
| 29401 | 38% | 62% | 0.1% | 53% | 2% | 37% | 7.4% |
| 29403 | 19% | 80% | 0.9% | 42% | 25% | 21% | 11.0% |
| 29405 | 14% | 85% | 1.0% | 57% | 30% | 11% | 2.3% |
| 29406 | 61% | 38% | 0.8% | 35% | 9% | 53% | 2.2% |
| 29407 | 39% | 58% | 2.6% | 60% | 6% | 30% | 4.1% |
| 29412 | 63% | 35% | 1.9% | 40% | 4% | 51% | 5.3% |
| 29414 | 80% | 19% | 1.0% | 20% | 1% | 76% | 2.2% |
| 29418 | 65% | 35% | 0.0% | 58% | 1% | 41% | 0.2% |
| 29420 | 45% | 54% | 0.6% | 63% | 2% | 34% | 1.3% |
| 29449 | 65% | 33% | 1.1% | 13% | 21% | 55% | 10.9% |
| 29451 | 94% | 3% | 2.1% | 14% | 2% | 82% | 2.1% |
| 29455 | 83% | 15% | 1.9% | 11% | 8% | 76% | 4.1% |
| 29464 | 94% | 4% | 2.4% | 9% | 2% | 88% | 1.4% |
| 29466 | 79% | 21% | 0.2% | 3% | 2% | 93% | 2.3% |

External Sources: Census Bureau, 2006 American Community Survey & 2000 Decennial Census; FY 2010 Property data for Charleston County

[a] Analysis includes greater Charleston area including: Mt. Pleasant, North Charleston, Hollywood, Hanahan, Isle of Palms and Kiawah Island.

[b] Residential property defined as parcels with use code equal to 10R (n=69,515)

[c] other heat / cooling systems: electricity radiant, solar, and baseboard heat

## V. OVERVIEW OF THE TRAFFIC LIGHT DEMAND RATING SYSTEM

### a. Methodology

To identify concentrations of high demand potential loan recipients, we create a set of demand indicators based on existing research from the Home Energy Saver program to categorize various housing characteristics (see measures of demand below).

Next, we assign each residential parcel points (1 – 3) for each determinant of demand, based on the demand level, then sum each parcel's points to fit into the Traffic Light Demand Rating System. Following this, a zip code-level index is generated by multiplying *number of housing units per point value* * *point value.* This creates a ranked ordering of potential demand, for all thirteen zip codes in the analysis.

Using our *Traffic Light Energy Retrofit Demand Index,* the final step is locating spatial concentrations of high demand customers within the greater City of Charleston (see map on Page 15).

### b. Measures of Demand

The Traffic Light Demand Rating System uses (4) housing characteristics, detailed below in the *Determinants of Demand* section, identified as influencing a household's demand for energy efficiency retrofits. For each of these (4) housing characteristics, we estimate potential demand for energy efficiency retrofits according to two measures of demand.

- The first measure of demand is the *energy efficiency/energy expenditure* for each housing characteristic. For example, although a home with larger square footage is more efficient per square foot than a smaller home, it has larger overall energy expenditures, and a higher demand for energy upgrades. Annual energy expenditures provide a basis for a cost-benefit calculation for the breakeven point where potential energy utility savings become greater than the total loan amount

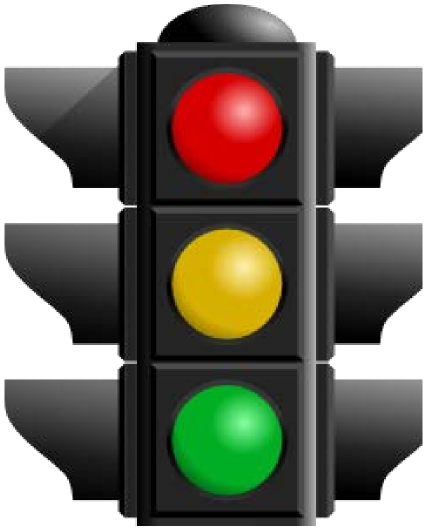
- The second measure of demand is the home's *energy retrofit upgrade project potential*. This measure takes into account project potential specific to the housing characteristics. For example, homes using natural gas are already more energy efficient than homes using electricity, but due to technologies specific to natural gas systems, possess more energy efficiency potential associated with upgrades than electricity powered homes.

Either *energy efficiency* or *retrofit project upgrade potential* is used to assign points to each residential parcel, as appropriate for each housing characteristic.

### c. Point System

Each of the (4) housing characteristics have specific thresholds identified as contributing to a home's energy efficiency, or retrofit upgrade potential. For the analysis, specific points are allotted to each characteristic in the following structure:

Figure 2 Traffic Light Demand System point values



**RED: Low Demand: Worth 1 Point**
There is very little potential for dollar and energy savings.

**YELLOW: Medium Demand: Worth 2 Points**
There is potential for dollar and energy savings, but specific retrofits would not increase energy efficiency as significantly as in *High Demand* homes, meaning energy bill savings for retrofits would be relatively low.

**GREEN: High Demand: Worth 3 Points**
A home with this characteristic possesses high potential savings from energy efficiency improvements.

For the CharlestonSAVES*TM* Demand Analysis, points are assigned to each residential parcel, for each of the (4) housing characteristics, creating a 12 point scale (3 max points * 4 characteristics = 4 – 12 point scale). In the summary *Potential Market for Residential Energy Retrofit Upgrades in the City of Charleston*, per parcel points are aggregated to the zip code level.

## VI. DETERMINANTS OF DEMAND

When viewing the charts below, look for zip codes with more green area to identify the concentrations of high demand across the City's zip code areas.

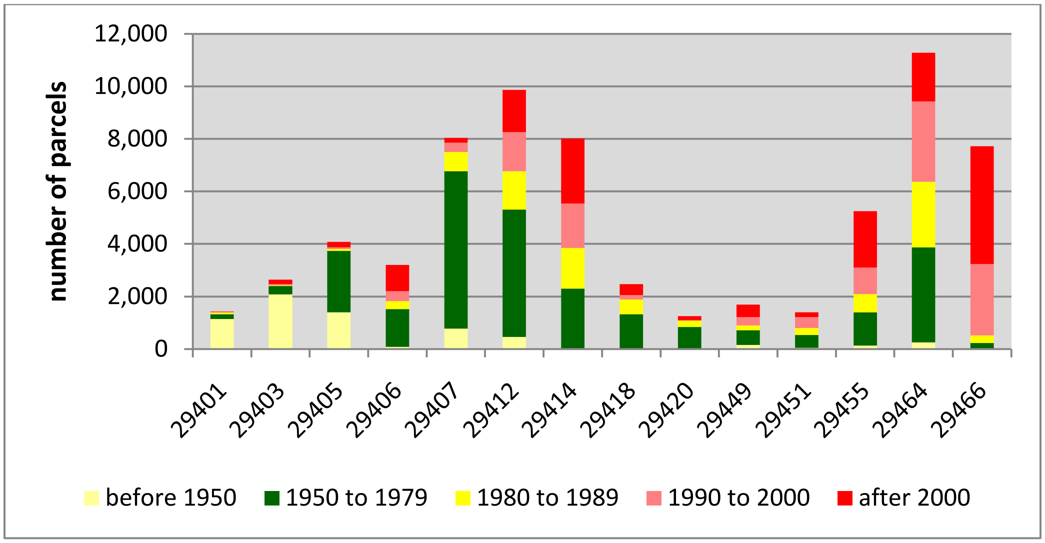
### a. <u>Year of Construction[1]:</u>

The year a property is built is one key determinant of potential energy and cost savings. Newer homes, especially those built within the last decade, are more likely to have energy

[1] Energy efficiency reference for 'Year of Construction' is Energy Information Administration (2005) Office of Energy Markets and End Use, Forms EIA-457 A-G of the "2005 Residential Energy Consumption Survey"

efficient appliances, while very old buildings, such as those built before 1940, may be difficult to retrofit.

Figure 3 Build year for residential housing in the City of Charleston, per zip code

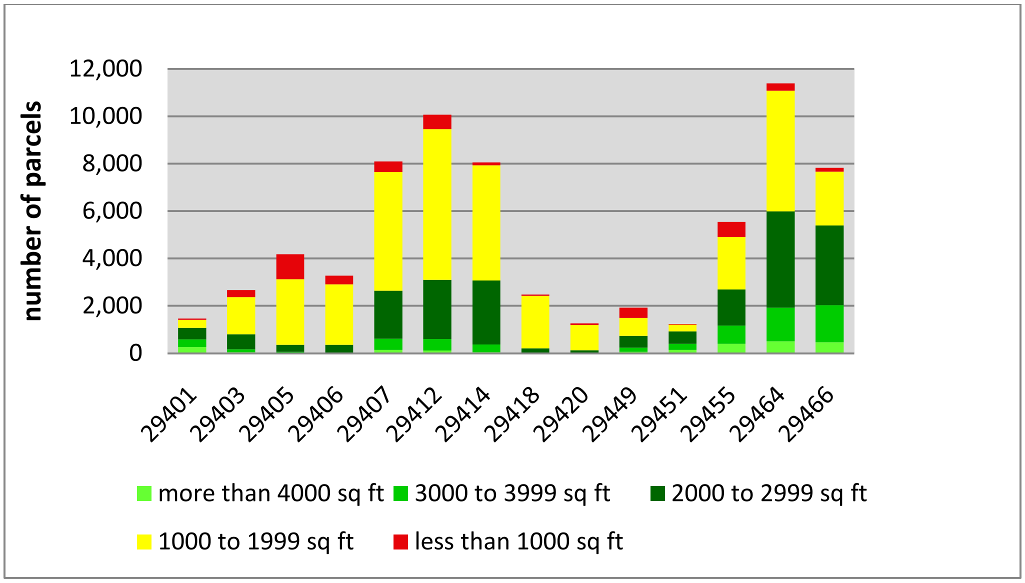



## b. <u>Housing Floor Space (Area)[2]:</u>

The size of a home also influences the potential for energy and cost savings. Larger homes are generally more attractive for many types of retrofits (e.g., air and duct sealing), due to the increased energy savings across the entire footprint of the home. However, houses that are very large, such as 4000+ square feet, begin to lose some of the benefits from retrofit improvements. For example, such a large home may have one heat pump for the basement and first floor, and another heat pump for the second and third floor. Therefore, paying to replace these two heat pumps with more energy efficient ones would not provide the same savings opportunity as replacing one inefficient heat pump that serves an entire 2000-2500 square foot home.

[2] Energy efficiency reference for 'Housing Area' is Energy Information Administration (2005) Office of Energy Markets and End Use, Forms EIA-457 A-G of the "2005 Residential Energy Consumption Survey"

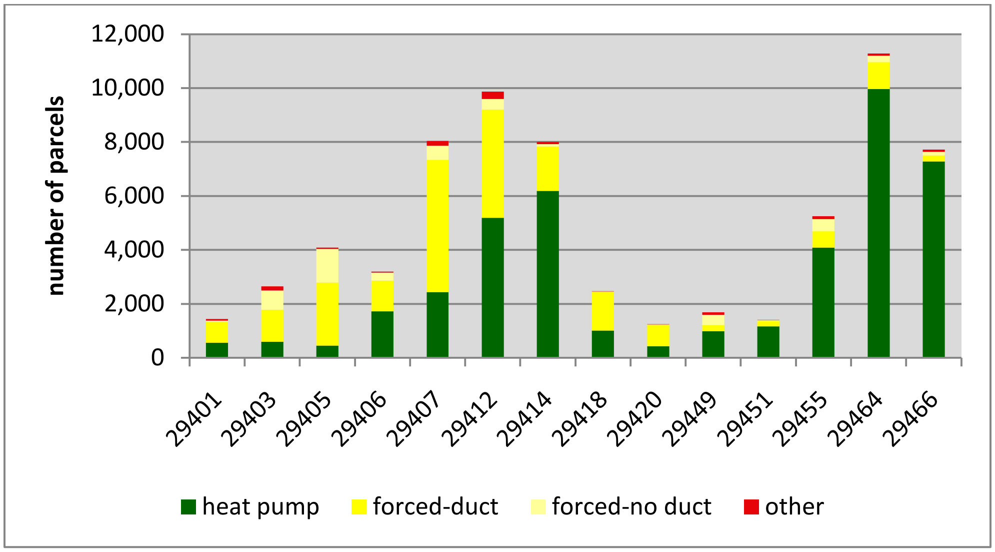
Figure 4 Residential floor space in the City of Charleston, by zip code




## c. <u>Heating System Type:</u>

The type of heating system also influences the potential for energy and cost savings from retrofits. On the drastic side, a home with no heating system has less potential for energy and costs savings. On the other hand, U.S. Green Building Council (USGBC) research demonstrates that new heat pumps are significantly more energy efficient than older heat pumps, and therefore, homes with heat pumps as part of their heating and cooling system possess relatively high potential for energy and cost savings. Other common heating system types include baseboard heat, forced duct, hot water and solar, which can be standalone or act as backup heat sources for heat pump systems.

Figure 5 Residential heat & cooling system types in the City of Charleston, by zip code




*Note: other heating and cooling system types include solar, baseboard heat, and electric-radiant*

## d. Fuel for Heating & Cooling:

The type of fuel used for heating and cooling homes is another key determinant. According to USGBC research, homes that are heated and cooled by natural gas have the highest potential for savings from energy efficiency improvements, followed by oil and electric.

Figure 6 Fuel source for residential parcels in the City of Charleston

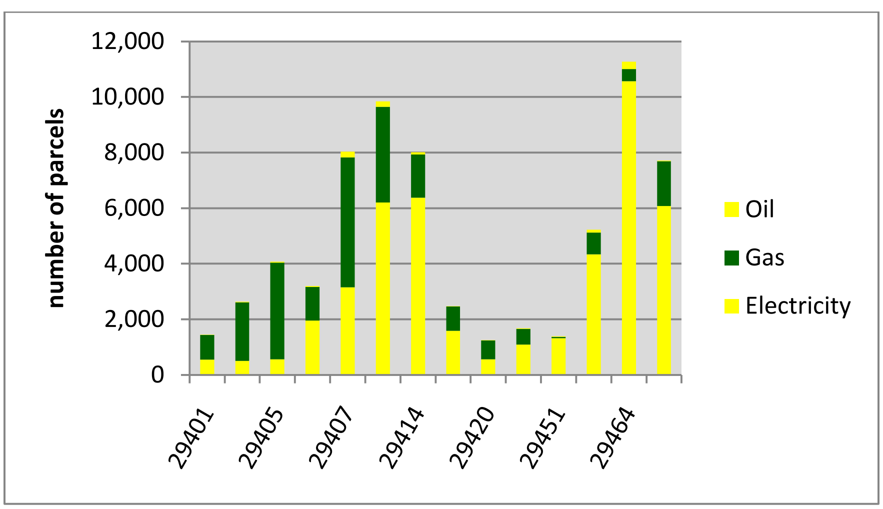
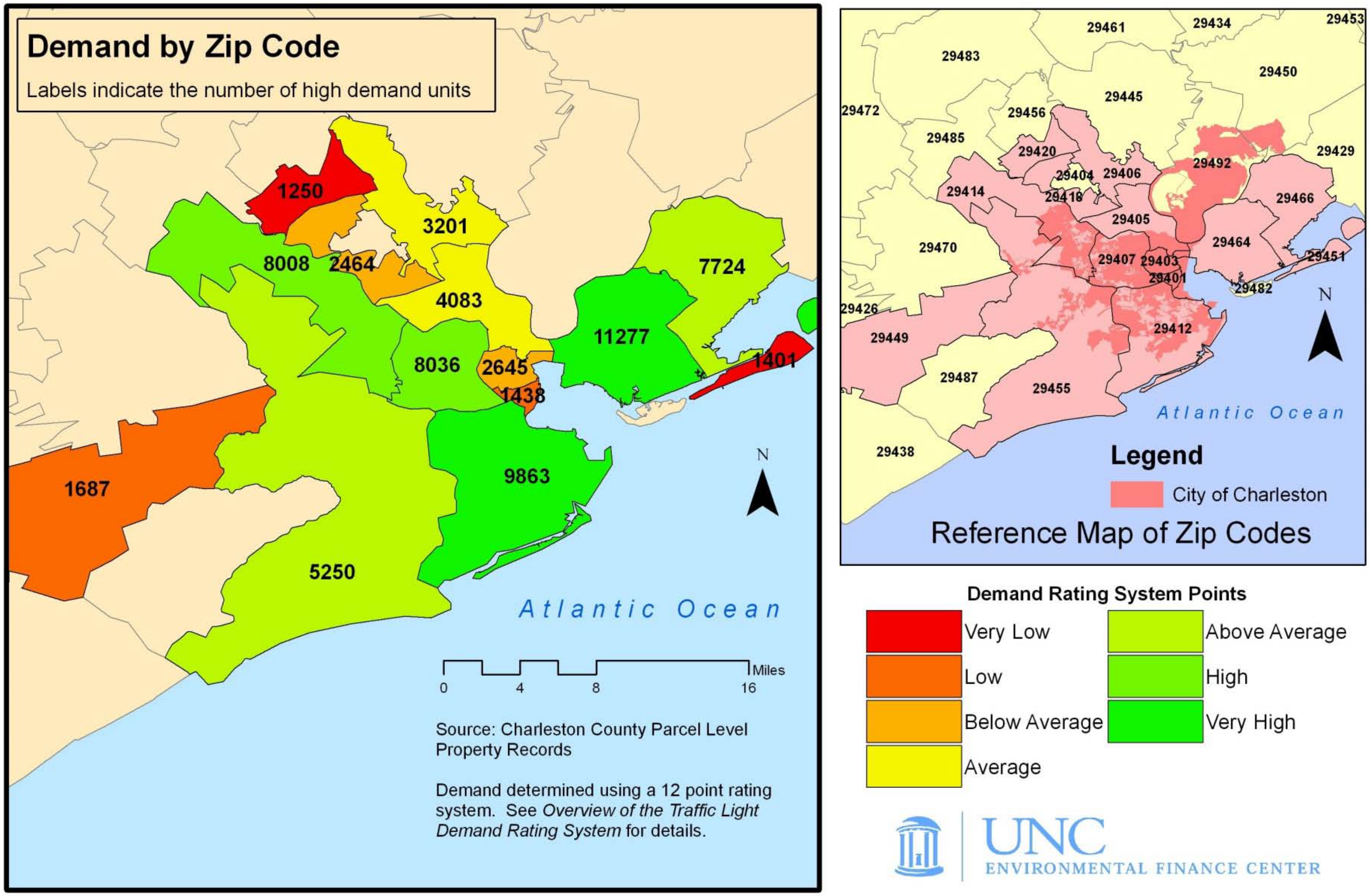


Figure 7 Potential Market for Residential Energy Retrofit Upgrades for the City of Charleston



## VII. POTENTIAL RETROFITS FOR A TYPICAL HIGH DEMAND HOME

To provide a snapshot into the types of retrofit improvements potential loan recipient households would undertake, we used the Department of Energy's Home Energy Saver calculator to create a profile of common improvements for representative high demand households in Charleston, SC.

Any project recommendations would be based on an audit assessment of cash flow positive or cash flow neutral payback. For residential energy retrofit loans, the monthly loan payment will be equal to or less than the household's monthly utility-bill savings.

To note, the estimated loan amounts assume that the homeowner decides to make all the recommended improvements within the upgrade package category. If a homeowner decided to only take on some of the recommended retrofit projects, the cost and loan amount would be lower.

**Representative High "Green" Demand Household in Charleston (12/12 points):**

Built in 1973, this home is 2500 Sq. Ft, uses an electric heat pump for its heating/cooling system, has a central air conditioner, and uses natural gas as fuel for its hot water heater. The home's average annual energy bill is approximately $2,450 ($204 per month).

Table 1. Annual energy bill savings for upgrade packages

| Upgrade Packages | Upgrade Cost (Range) | Annual Energy Bill Savings* |
|---|---|---|
| **Basic Efficiency Package** | | |
| Attic Insulation | $1,250 - $1,875 | $260 |
| Wall and Crawl Space Insulation | $2,250 - $2,750 | $250 |
| Air Sealing: 25% air leakage reduction | $2,500 - $3,750 | $120 |
| Duct Sealing: Reduce leakage to 6% | $2,500 | $106 |
| | ***Total: $8,500 - $10,875*** | ***$736/yr*** |
| **Medium Retrofit Package** | | |
| Attic Insulation | $1,250 – $1,875 | $260 |
| Wall and Crawl Space Insulation | $2,250 - $2,750 | $250 |
| Air Sealing: 25% air leakage reduction | $2,500 - $3,750 | $120 |
| | $2,500 | $106 |
| Duct Sealing: Reduce leakage to 6% | $5,000-$6,000 | $513 |
| SEER 14 Heat Pump (4 ton unit) | | |
| Gas Water Heater (62% efficiency) | $900 - $1,050 | $60 |
| | ***Total: $14,400 - $17,925*** | ***$1,455/yr*** |
| **Deep Retrofit Package** | | |
| Attic Insulation | $1,250 - $1,875 | $260 |
| Wall and Crawl Space Insulation | $2,250 - $2,750 | $250 |
| Air Sealing: 25% air leakage reduction | $2,500 - $3,750 | $120 |
| | $2,500 | $106 |
| Duct Sealing: Reduce leakage to 6% | $5,000 - $6,000 | $513 |
| SEER 14 Heat Pump (4 ton unit) | $900 - $1,050 | $60 |
| Gas Water Heater (62% efficiency) | $600 - $1,000 | $146 |
| Clothes Washer (Energy Star) | $11,000 - $15,000 | $184 |
| 2 pane Energy Star Windows | | |
| Cool roof: Solar reflectance | $3,000 - $5,000 | $29 |
| | ***Total: $29,000 - $38,925*** | ***$1,668/yr*** |

* Annual energy bill savings are the estimated reduction in energy bill amounts, per retrofit, for the representative home. These annual savings are estimated as cost savings over and above the minimal building code mandated for new units. Accordingly, savings may be underestimated if residential units do not meet minimal new construction standards prior to retrofit.

## VIII. KEY FINDINGS FOR CITY OF CHARLESTON

Based on our methodology and analysis, we were able to provide CharlestonSAVES*TM* with concrete recommendations for program rollout. These recommendations included specific zip codes to target, retrofit upgrades to focus on, and heating systems that have the greatest potential for upgrades. Below are the recommendations the Environmental Finance Center provided to CharlestonSAVES*TM* based on our Demand Analysis:

**1) Zip Codes 29412 and 29464 Represent Top Targets**

Using our ratings system, these two zip codes each have over 9,800 high demand residential units for energy efficiency upgrades. Mount Pleasant's 29464 zip code has the greatest number of high demand residential units, totaling 11,277. Both of these areas present a big opportunity for program rollout.

**2) Three Core Zip Codes Provide Opportunity for Focused Program Rollout**

29414, 29407 and 29412 each have over 8,000 high demand residential units, and taken together, total nearly 26,000 high demand units for energy efficiency upgrades. Accordingly, CharlestonSAVES*TM* could focus its marketing and program rollout in these adjoining areas of the city to increase positive spillover of program efforts to gain homeowner participation.

**3) Heat Pumps are a Great Opportunity within the Residential Retrofit Market**

Our analysis finds upgrading heat pumps in homes with older heat pumps is one of the top dollar and energy savings retrofit measures homeowners can undertake. Heat pumps are very common in Charleston homes, and CharlestonSAVES*TM* could focus on heat pump upgrades as part of marketing and promotional efforts, specifically in high demand zip codes with high percentages of homes with heat pumps, including 29412, 29414 and 29464.

**4) Homes Fueled by Natural Gas are Prime Retrofit Program Targets**

Homes fueled by natural gas are prime retrofit targets due to high potential for energy and dollar savings. In the City of Charleston, two adjoining zip codes that possess high residential demand also have abnormally high percentage of gas-powered homes, specifically, 29407 and 29412. Accordingly, marketing rollout within these zip codes could focus on the potential for cost savings from upgrading old gas water heaters and/or furnaces to more energy efficient models.

## IX. CONCLUSIONS AND NEXT STEPS

These determinants remain untested as the CharlestonSAVES*TM* Program has yet to launch. To continue to refine and develop this methodology, the next step is to evaluate program performance and measure loan uptake and repayment – in mid-stream first generation programs – in order to modify and improve targeted marketing in early stages of program development. Moreover, incorporating other critical components of market demand, including customer repayment history (either through water or electric utility bills), would further enhance our current methodology. As noted in a prominent study on residential retrofit programs, determinants of demand will be unique to each place (Fuller 2010, page 4), thereby making the availability of local data and examining location-specific customer and climate characteristics critical to forecast demand.

As green finance programs continue to develop products, policies and strategies, it has become clear in this study and several others, that high demand financing customers are not the customers most in need of energy efficiency upgrades and cost savings (Fuller 2009, page vii), as they tend to be economically secure and live in higher-end homes. Therefore within communities, lower-income citizens and tenants may be burdened with higher energy usage and bills, and have less access to resources to make improvements in their homes. Further research could build off our residential market demand model, and incorporate unique ways of assessing potential customer's ability to take on energy-saving retrofit loans, possibly incorporating utility bill or mortgage payments, to better target lower-income tracts that could benefit from financing for retrofit upgrades and cost savings.

Moreover, there are large potential markets for EERE loan programs outside of the residential sector that require separate demand forecasting models and strategies, principally the commercial and industrial sectors. The commercial sector possesses a landlord-tenant disconnect with regards to the payment of energy bills, with tenants typically paying energy bills, which complicates how to forecast and stimulate green finance programs. In the industrial sector, identifying specific upgrades that companies would benefit from is a core component of forecasting, but there needs to be a better understanding of how industrial sector companies make strategic financial investments to more effectively rollout industrial EERE loan programs. The methodology depicted in this paper provides a good base for demand forecasting and program rollout in residential sector EERE loan programs, and should be built upon to help forecast and stimulate demand in the commercial and industrial sectors.

## X. SUMMARY

Our demand analysis methodology enables energy efficiency and renewable energy (EERE) lending program administrators to use residential or commercial building characteristics (and credit history through utility bill repayment) to understand and measure demand. This allows administrators to create actionable program rollout strategies at the block, zip code or county level. Existing research identifies strategies to improve marketing efforts, and our methodology adds to this effort by enabling program administrators to better target locations for EERE program rollouts, which allows for further customization of marketing efforts (i.e., the two research strands complement one another).

Our methodology currently possesses four key determinants of demand, and taken together, these determinants can help program administrator target EERE lending program rollout. These four determinants of demand are related to building characteristics, and comprise of 1) Year of construction, 2) Housing floor space (area), 3) Heating system type and 4) Fuel for heating and cooling. These residential building characteristics could also be combined with credit history, either through FICO scores or utility bill repayment, to provide a more comprehensive building and financial picture of potential clients for program administrators.

We apply this relatively novel methodology to the CharlestonSAVES*TM* Program to help inform target areas within the city and to identify key potential upgrades that would provide residential participants more energy savings. Using the ratings system built off the four determinants of demand, our analysis enabled specific recommendations for the EERE lending program rollout, including:

- Zip codes CharlestonSAVES*TM* should initially target for program rollout because of concentration of high demand residential units;
- Specific retrofit upgrades that will provide customers with the largest energy savings, which can guide marketing and promotional efforts; and

- Type of homes to target, those fueled by natural gas for heating and cooling, which provide homeowners with the highest potential for financial and energy savings. Analysis included identification of the two zip codes in Charleston with the densest concentration of natural gas-fueled homes.