

Carrboro, North Carolina: Achieving Building Efficiencies for Low-Income Households

The Town of Carrboro partnered with the U.S Department of Energy (DOE) and the National Renewable Energy Laboratory (NREL) to demonstrate how data analysis can be used to assist with strategic energy planning. NREL based this analysis in part on data from DOE's State and Local Planning for Energy (SLOPE) Platform and the Low-Income Energy Affordability Data (LEAD) Tool. Cities across the country can follow the same approach and use data-driven analysis in their own energy planning.

City Energy Goal

Through its climate action plan, the Town of Carrboro North Carolina, set a goal to reduce greenhouse gas emissions by 50% by 2025.¹ Specifically, Carrboro sought to improve building energy efficiency without passing the costs to low-income renters. To meet this goal, Carrboro government officials wanted to develop targeted building energy actions and policies that would benefit low-income households.

For context, Carrboro, North Carolina is a "bedroom community" that houses many students from the nearby University of



"The Cities-LEAP analysis provided data not readily or easily accessible for me, drilled down with some more sophisticated analyses than we would be able to pursue locally, provided a more national context, and highlighted options and resources to consider as Carrboro begins to move from a phase of developing a local climate action plan to implementing the plan."

- Randy Dodd, Environmental Planner, Town of Carrboro

North Carolina at Chapel Hill. Rental units are 60% of the housing stock. More than 85% of the total building area in Carrboro is composed of residential units (Figure 1).

This data was extracted from SLOPE's 2013 commercial building stock data.²

Commercial building stock data can help jurisdictions understand the potential scope and impact of programs or policies like building energy benchmarking, set targets for goal achievement, and establish metrics to measure progress.





1. Community Climate Action Plan: http://www.townofcarrboro.org/928/Community-Climate-Action-Plan.

^{2.} SLOPE Data Viewer (2024) Commercial Building: https://maps.nrel.gov/slope/data-viewer?filters=%58%5D&layer=bldg-benchmarking.building-count&year=2020&res=state.

Data and Analysis

To conduct the analysis, NREL evaluated the estimated city energy data and building composition available on SLOPE and LEAD, supplemental data from publicly available sources, and data inputs obtained directly from Carrboro, North Carolina.

Reducing Building Energy Consumption

They found that single-family dwellings accounted for approximately 61% of the residential building area and 85% of the number of residential buildings (Figure 2).

Given that a significant portion of Carrboro's building stock was in the residential sector, the town became particularly interested in energy efficiency measures for single-family homes. However, this analysis showed that Carrboro's low- and moderateincome residents are more likely to be living in multifamily dwellings (Figure 3).



Figure 2. Residential building stock area by building type (2013) in Carrboro, North Carolina (Source: LEAD)

Achieving Low-Income Household Energy Savings

Of the 8,723 occupied housing units in Carrboro, an estimated 60% are renteroccupied, which is nearly twice the average percentage of renter-occupied units in North Carolina (34.9%) and nationally across the United States (36.1%).³ Further, Carrboro's residential



Figure 3. Number of housing units by housing type and area median income (2015) in Carrboro, North Carolina (Source: U.S. Census, U.S. Housing and Urban Development, and Energy Information Administration data⁶)

per capita electricity usage is more than twice the national average. Per capita annual residential electricity expenditures are an estimated \$270 higher than the national average.⁴

The U.S. Department of Housing and Urban Development (HUD) determines low-income status by the percentage of the area median income (AMI) for a given location that a household makes. HUD defines "very low income" as households earning 50% or less of AMI.5 Based on an analysis by HUD and the U.S. Census data, approximately 34% of renter-occupied units are occupied by very low-income renters (Figure 3). This could mean that renters in Carrboro may fall into lower income brackets than their homeowner counterparts. Renters in Carrboro, North Carolina are also likely to be living in multifamily buildings; 71% of all renter-occupied units are in buildings with three or more housing units.

Another important component to consider beyond AMI, rent vs. owning status, and building characteristics is energy burden. Measured as the ratio of energy expenditures to household income, energy burden is a metric commonly used to evaluate the relative cost burden of energy expenditures on households. Renter-occupied households have lower energy burdens than owner-occupied

- 3. U.S. Census Bureau, American Fact Finder: Selected Housing Characteristics, 2011–2015 American Community Survey 5-Year Estimates.
- 4. 2013 SLOPE data from the Cost of Energy Average Residential Electricity Costs layer.

^{5.} State and county-level income limits are updated every fiscal year and are based on the number of people per household. Income limit documentation is available at https://www. huduser.gov/portal/datasets/il.html.

^{6.} Figure based on an NREL residential household disaggregation and cross-tabulation of the U.S. Census, U.S. Housing and Urban Development, and Energy Information Administration data. Similar data and the associated methodology will be available for all cities in SLOPE.



Figure 4. Average energy expenditures and energy burden for residential sector (2015) for Carrboro, North Carolina (Source: U.S. Census, U.S. Housing and Urban Development, and Energy Information Administration data⁷)



Figure 5. Number of housing units by heating fuel type and ownership status (2015) in Carrboro, North Carolina (Source: Data from U.S. Census Bureau, American Fact Finder: Selected Housing Characteristics, 2011–2015 American Community Survey 5-Year Estimates)

households in corresponding AMI categories for Carrboro households (Figure 4). This could be partially influenced by the fact that renter households across all of the AMI categories in Carrboro have lower total annual energy costs than owner-occupied households. This situation may correlate with factors such as differences in unit area and household size, as well as shared walls and rental units that do not have separately metered utilities. Further, an estimated 81% of rental units are electrically heated compared to approximately 41% of owner-occupied units being heated by electricity (Figure 5). The slightly lower energy burden among renters may also be correlated with the increased likelihood that rental units are electrically heated, as average monthly expenditures on electricity are lower than other forms of heating in Carrboro (Figure 6).

An analysis⁸ of potential energy cost savings in single-family detached homes in each state, based on a detailed modeling of 350,000 representative individual houses found that the following are the most cost-effective measures in North Carolina:

- 1. Installing smart thermostats
- 2. Replacing propane furnaces with variable-speed heat pumps
- 3. Adding 1-inch (R-5) insulated sheathing at siding wear out
- Upgrading to ENERGY STAR[®] clothes washers
- 5. Drilling into exterior walls and filling with insulation.

Approaches to Reduce Energy Burden & Increase Energy Efficiency

In Carrboro, programs that target energy efficiency upgrades in multifamily buildings may have a greater impact on the low-income population. Additionally, because rental units in Carrboro are already more likely to use electricity as a heating source, and because average monthly electricity expenditures are low relative to other heating fuels, converting rental properties from bottled gas, which is generally propane, to variable-speed heat pumps may target support to units with occupants that experience a higher energy burden.

^{7.} International Energy Conservation Code Resource Page, International Code Council, https://codes.iccsafe.org/.

^{8.} E. Wilson et al., Electric End-Use Energy Efficiency Potential in the U.S. Single-Family Housing Stock, National Renewable Energy Laboratory (2017), p. 95, https://www.nrel.gov/ docs/fy18osti/68670.pdf.



Figure 6. Estimated average monthly expenditures by heating fuel type (2015) in Carrboro, North Carolina (Source: U.S. Census, U.S. Housing and Urban Development, and Energy Information Administration data⁹)

Additional measures to increase the efficiency of low-income and rental properties include the following:

- Time-of-sale efficiency requirements
- Rental and low-income weatherization programs
- Mechanisms to disclose anticipated utility bills to potential renters and buyers
- Requiring renovations to meet code
- · Improving code compliance rates
- Adopting beyond-code measures (i.e., city policies that go beyond state-level or the latest vintage of building codes, such as the International Energy Conservation Code⁷)

• Requiring new multifamily developments to meet efficiency standards in order to receive zoning and development approvals.

Resources

The following resources may be useful:

Multifamily Residential Energy Efficiency

- North Carolina's Multifamily Energy Efficiency Collaborative: https:// cleanenergy.org/blog/reducing-theenergy-burden-in-the-southeasttackling-energy-efficiency-inmultifamily-housing/
- Resources for Multifamily Properties: Navigating Efficiency Policies and Incentives: https:// betterbuildingssolutioncenter.energy. gov/beat-blog/resources-multifamilyproperties-navigating-efficiencypolicies-and-incentives

Renter-Owner Split Incentives

• Policy options for the split incentive: Increasing energy efficiency for low-income renters: http://www. sciencedirect.com/science/article/pii/ S0301421512004661

For other resources, please visit:

State and Local Solution Center Resource Database: https://www.energy.gov/scep/ slsc/state-and-local-solution-centerresource-database

Better Buildings' Clean Energy for Low-Income Communities (CELICA) Toolkit: https:// betterbuildingssolutioncenter.energy.gov/ CELICA-Toolkit

EPA's Guide on Energy Efficiency in Affordable Housing: https://www.epa. gov/sites/default/files/2018-07/ documents/final_affordablehousingguide_ 06262018_508.pdf

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U.S. DEPARTMENT OF ENERGY

Share your feedback and questions with us at LEAD.Tool@hq.doe.gov.

9. Figure based on an NREL residential household disaggregation and cross-tabulation of U.S. Census, U.S. Housing and Urban Development, and Energy Information Administration data.

