COMMUNITY CLIMATE
COLLABORATIVE

UNCOVERING ENERGY INEQUITY

Executive Summary

Charlottesville, VA | July 2020

The Community Climate Collaborative (C3) sought to understand which neighborhoods in Charlottesville, Virginia, are most at risk of bearing unsustainable energy costs, and why energy inequity is occurring in those places. This report focuses on energy equity by examining energy burden (the portion of household income that is spent on energy costs) throughout the City and how it relates to other physical and demographic factors.

Introduction

Climate change, and the impacts of increasing temperatures, will not fall evenly across our community. As temperatures rise, so will energy costs, disproportionately affecting low-income households who are already significantly burdened by housing costs. Without the ability to mitigate the effects of rising temperatures on their energy bills with energy efficiency upgrades and clean energy technology, low-income communities will be at a greater risk for heat-related health problems and respiratory illnesses and will suffer from even greater housing unaffordability. Through this report, the Community Climate Collaborative (C3) sought to understand which neighborhoods in Charlottesville, Virginia, are most at risk of bearing unsustainable energy costs, and why energy inequity is occurring in those places.

This report focuses on energy equity by examining energy burden (the portion of household income that is spent on energy costs) throughout the City and how it relates to other physical and demographic factors. Prior reports on energy burden in our community have examined data at zip code level or less precise areas. For Charlottesville, this means aggregating in a single area up to nearly 15,000 households (of shared population between Charlottesville and Albemarle), which allows important pockets of energy inequity to remain hidden within the data. C3 wanted to dig deeper. Without conducting extensive neighbor surveys, the most granular data available for energy costs is at the census tract level. There are 12 census tracts within Charlottesville, each with approximately 1,000+ households. As such, this report was able to identify important relationships (and the lack of them) between demographic and building stock features and how energy burden overlaps with the key drivers of unaffordable housing. However, it was not possible to determine causation as to whether energy costs or household income level was the primary driver for energy burden for individual households.

The most important finding of this report is that we now understand where, geographically, the important work of relieving energy burden must begin and what factors should be prioritized when designing municipal policies with energy equity goals. Five census tracts in Charlottesville face disproportionate incidence of elevated energy burden — each with 500 or more households spending more than 6% of their income on energy costs. It is in these tracts that we must focus our future efforts to increase energy equity and build climate resilience.

Determining precise and efficient solutions will require further analysis and extensive community engagement with residents in impacted neighborhoods, but solutions exist. By and large, we anticipate that where homes are suffering from high energy costs, especially from air conditioning use in warmer seasons, energy efficiency can help to dramatically lower energy burden. Where homes are suffering from low income but are energy efficient, a low-income solar program could lower energy burden by eliminating electricity bills. Many homes will be good candidates for a combination of energy efficiency and solar energy improvements. C3 looks forward to partnering with stakeholders and residents to develop comprehensive and targeted solutions to alleviate energy burden in Charlottesville, while advancing the City's energy equity and supporting its climate action efforts.

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Energy Equity and Energy Burden

Energy Equity is defined as a context in which all households have equitable access to clean, affordable, and secure energy services, regardless of their demographic characteristics (such as ethnic background, income levels, geographic location, etc.).

Energy Equity may overlap with Climate Justice as communities without equitable access to energy may not be able to combat the effects of climate change (such as rising temperatures), despite historically contributing less to human-led global warming.

Energy Burden refers to the portion of a household income spent on home-energy costs, including electricity, natural gas, propane, and other energy sources. C3 further defined:

- High Energy Burden: between 6.0% and 9.9% of household income
- Very High Energy Burden: between 10.0% and 19.9% of household income
- Extremely High Energy Burden: 20.0% or higher of household income

Key Findings

- 4,852 households in Charlottesville face high to extremely high energy burden levels. Four Charlottesville census tracts are, each of them, home to 500+ highly energy burden households.

- 4,031 households spend more than 10% of their annual income on energy costs.

- While Charlottesville's average energy burden is 2.3%, extremely-Low Income households face the highest average energy burden, of approximately 16% of their income.

- Given a same built year, homes occupied by renters seem to bear energy burden levels up to twice as much as the homeowners' average.

- When controlled by income levels, the average energy burden faced by households appear to be uncorrelated with their homeownership status.

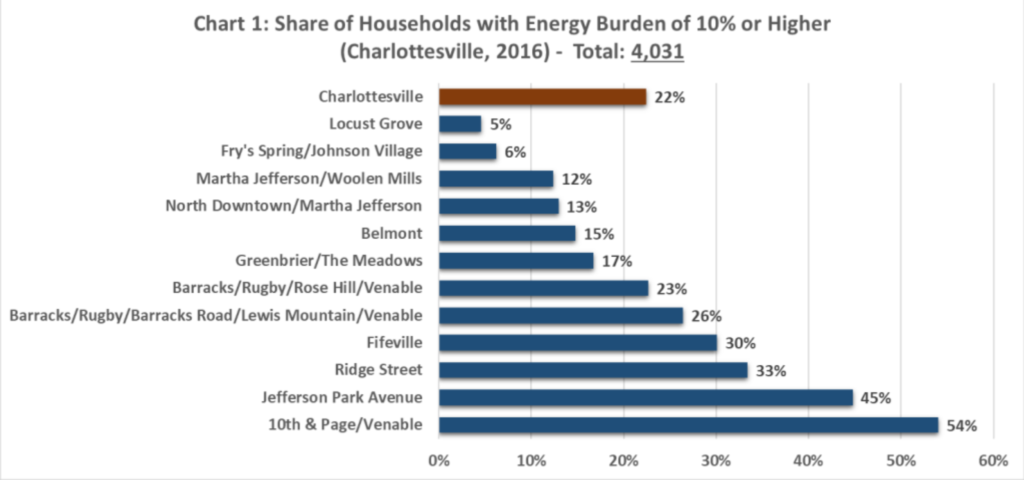
- There is no clear link between the age of home units and the energy burden levels faced by their households.

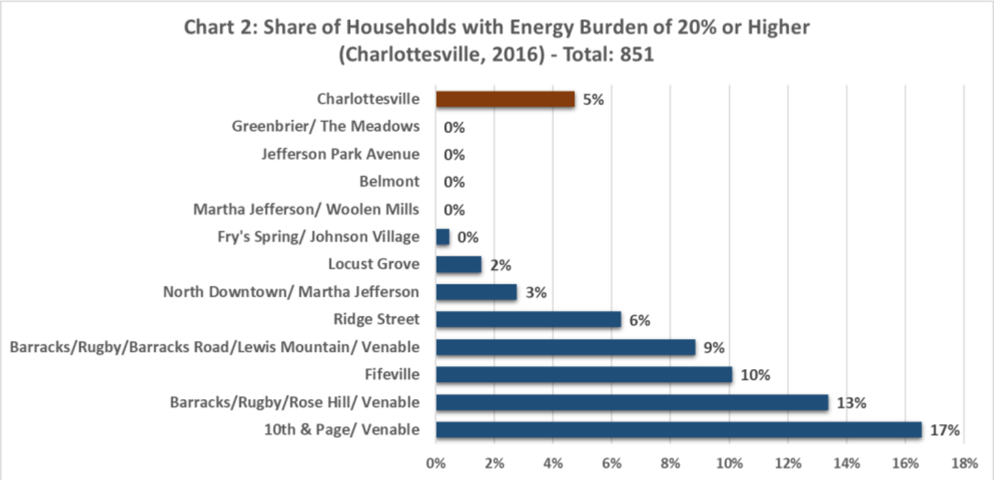
- Reducing households' energy burden to 6% in a targeted manner, could free up to 18% of each beneficiary's annual income.

Energy Burden in Charlottesville, Virginia

4,852 households in Charlottesville face high to extremely high energy burden and are clustered in a handful of neighborhoods. While the City's overall energy burden of approximately 2.3% per household is below the median from America's largest cities, the distribution of that burden among Charlottesville's residents/neighborhoods is not even or equitable. The most severely energy burdened census tract, corresponding to 10th & Page/Venable neighborhoods, exhibits a stunning 54% of households (or a total of 770 households) with a very high to extremely high energy burden (i.e. an energy burden of 10% or higher). Several other census tracts are also home, each of them, to approximately 500 or more households that are experiencing a high energy burden or more. Meanwhile, as observed on Chart 1, very high energy burden levels were faced by only 5% of the households living in the census tract with the lowest incidence of this burden level (Locust Grove area).

When looking only at extremely energy burdened households —those spending 20% or more of their income on energy costs — the inequity is even more pronounced. In all, 851 households are extremely energy burdened, and 236 of those are in the 10th & Page/Venable neighborhoods. Three other census tracts have more than 100 households each with extreme energy burden, conversely, half of the City's census tracts have 16 or fewer households with extreme energy burden.





Student Dominated Census Tracts

According to previous affordable housing studies, 39% of Charlottesville area residents with incomes below the poverty level are [UVA] students. Students typically have other sources of financial support, making it difficult to estimate (without a neighborhood level survey) a truly accurate count of non-student households facing elevated energy burden levels in student dominated census tracts (Barracks/Rugby/Rose Hill/Venable, 10th & Page/Venable, and Jefferson Park Avenue). These tracts house nearly 47% of the City's extremely high energy burdened households (Table 1), and that burden is most likely heavily influenced by the unusual low-income levels of undergraduate students.

TABLE 1	Count of Households with High Energy Burden (Charlottesville, VA)			
Census Tracts	High Energy Burden [Alone]	Very High Energy Burden [Alone]	Extremely High Energy Burden [Alone]	Total
Student Dominated	134	1170	396	**1700**
Non-student Dom.	687	2010	455	**3152**
Total	**821**	**3180**	**851**	**4852**
Source:	Own elaboration based on data obtained from the U.S. Department of Energy's Low-Income Energy Affordability Data (LEAD) Tool (values for 2016).			

While there may be a temptation to dismiss energy burden in student dominated tracts, it should be acknowledged that these tracts are also home to some of the City's largest percentage of populations of color and of individuals aged 25 years or more (thus, likely non-undergraduate students) that have completed education equivalent to high school diploma or less. Thus, C3 recognized that it is important to consider all census tracts when analyzing the City's energy burden levels.

Since, currently available data does not allow for a separate analysis of demographic features of students and non-student households within the same census tract, C3 recommends further analysis of these dynamics within student dominated tracts in order to not overlook historically economically disadvantaged communities.

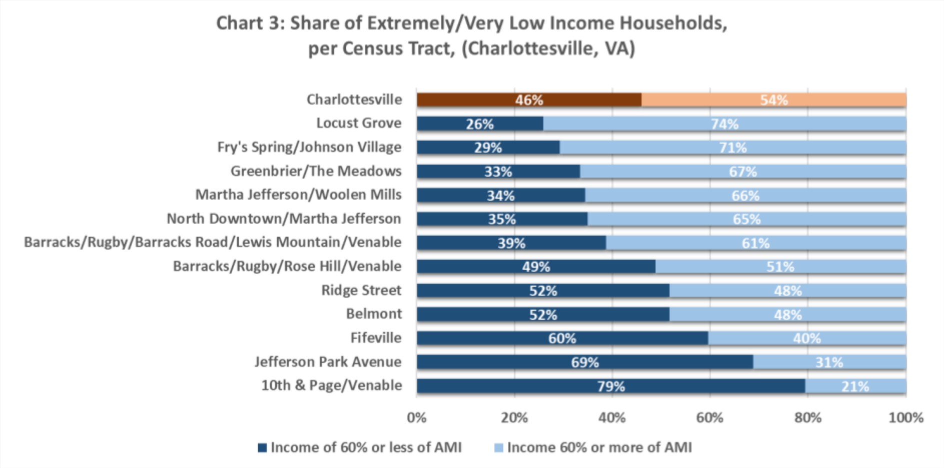
Key Drivers of Energy Burden

The determination of a household's energy-cost burden relies on the interaction of two key variables: the household's home-energy costs and the household's income level. Consequently, each of these variables should be considered to be the primary drivers of households' energy burden levels. Additional factors can play a role in determining either or both the households' home-energy costs and or income level, and hence, in determining their energy burden levels. Among these factors are the household size, the building-structure energy efficiency (e.g. building stock features), and the household's demographic characteristics, which include education level, gender, and race.

Using data from Charlottesville Open Data, the United States Census Bureau and the US Department of Energy's LEAD Data Tool, C3 analyzed each of these variables as potential drivers of energy burden. Better understanding which are the most influential drivers of energy burden in Charlottesville can provide valuable information to decision-makers, allowing them to better design and implement climate policies with the highest energy conservation potential while significantly increasing the livability of Charlottesville's most economically-distressed households.

Income

Not surprisingly, income emerged as the most prominent determinant of high energy burden across all census tracts. Extremely low-income households across the City face an average energy burden of 16%. The census tracts with the highest share of extremely or very low-income households, also presented the highest energy burden levels (Chart 3).



Home Ownership

Nearly 58% of Charlottesville households are renters. The most striking outliers are Jefferson Park Avenue and 10th & Page/Venable, where 93% and 83% of all households are renter-occupied, respectively. This is likely a result of their close proximity to the UVA campus and potential higher proportion of student-occupied housing. Other tracts, such as Barracks/Rugby/Rose Hill/Venable and Fifeville, also deviate from Charlottesville's distribution of owner versus renter-occupied homes, with the share of renters significantly larger than the City's average. As expected, these neighborhoods, besides having lower homeownership incidence, are among the census tracts with the highest energy burdens. Given a same built year, homes occupied by renters seem to bear energy burden levels up to twice as much as the homeowners' average.

In contrast, the Locust Grove neighborhood shows that nearly two thirds of its households are owner-occupied, a share nearly 60% higher than Charlottesville's average. Also as expected, this census tract experiences the City's lowest average energy burden and incidence of households with elevated energy burden levels.

TABLE 2	Avg. Energy Burden per Income Level and Home Building Year, (Charlottesville, VA)	
Income Level	Renter-Occupied	Owner-Occupied
Extremely-Low [Alone]	16%	16%
Very-Low [Alone]*	5%	6%
Low [Alone]*	3%	4%
Moderate [Alone]	3%	3%
100% or more of AMI	1%	1%
Source:	Own elaboration based on data obtained from the U.S. Department of Energy's Low-Income Energy Affordability Data (LEAD) Tool (values for 2016). *Both income brackets are defined with 60% of AMI as a threshold, instead of 50%.	

While the share of renter-occupied homes within a census tract was linked directly with higher energy burden levels, income remained the more dominant factor. As observed on Table 2, when controlling for income, households within the same income-bracket experience similar average energy burden levels regardless of their homeownership status.

Race

Although C3 was not able to find any dataset that provided data regarding levels of energy burden per race in Charlottesville for 2016, a statistical analysis allowed us to observe that the prevalence of "white alone" households within tracts had an inverse correlation with higher energy burden levels, while the presence of African

American households was directly linked to increased energy burden levels.

Age of Building Stock

C3 focused on building structure ages to analyze building stock features, using this variable as a potential proxy of a home's overall energy efficiency levels. Overall, Charlottesville has fairly new building stock, with 69% of homes built after 1980, and approximately 88% of the City's families living in homes that were built after 1960.

Again, C3 confirmed the dominance of income over other factors and found that, when controlling for income, there is no relationship between building structure ages and the energy burden levels in the City. This is a surprising result, as energy burden is generally associated with older and inefficient homes. Moreover, C3 identified that 614 households living in homes built between 1980 and 1999 face extremely high energy burdens. These 614 households represent 72% of the City's total count of households facing this level of energy burden and 12.6% of all households living in buildings constructed during this period, as depicted on Table 3). This is another counterintuitive finding that demonstrates how general beliefs, such as that higher energy burdens are associated with older homes, might not necessarily apply in Charlottesville.

TABLE 3	Share of Households with High Energy Burden Levels per Home Building Year (Charlottesville, VA)			
Year Built	High Energy Burden [Alone]	Very High Energy Burden [Alone]	Extremely High Energy Burden [Alone]	Total
Before 1940	1.5%	13.2%	5.5%	**20.2%**
1940 - 59	2.7%	12.3%	2.6%	**17.6%**
1960 - 79	2.9%	25.1%	4.8%	**32.8%**
1980 - 99	4.2%	11.8%	12.6%	**28.6%**
2000 - 09	4.1%	16.5%	0.0%	**20.6%**
2010+	9.6%	25.1%	0.0%	**34.7%**
Total	**4.7%**	**18.4%**	**4.9%**	**28.0%**
Source:	Own elaboration based on data obtained from the U.S. Department of Energy's Low-Income Energy Affordability Data (LEAD) Tool (values for 2016).			

Addressing Housing Affordability Through Energy Equity

Energy affordability has a direct impact on housing affordability. Housing is considered to be affordable when the housing costs experienced by the household represent less than 30% of its annual income. For renters and homeowners alike, home-energy costs are a key component of their overall housing costs. In Charlottesville, 4,852 households pay more than 6% of their annual income on energy costs each year, while 4,031 pay more than 10%, and 851 pay more than 20%. Hence, it is important to highlight that considerable improvements in the City's housing affordability levels could be achieved by significantly reducing Charlottesville's energy burden levels.

Addressing Energy Inequity in Local Climate Planning

The City of Charlottesville has established goals to reduce net greenhouse gas (GHG) emissions by 45% by 2030 and to achieve carbon neutrality by 2050. The City has also committed to addressing equity in its Climate Action Plan and related policies in an effort to make climate programs accessible and affordable for all residents in the area. Furthermore, C3 recognizes that addressing Charlottesville's current affordable housing crisis is of utmost importance. In this setting, Charlottesville's Climate Action Plan has the opportunity to prioritize equity and expand housing affordability - all while reducing climate emissions.

Expected temperature increases caused by climate change could increase Charlottesville's average daily maximum temperature by

8˚F over the next 80 years. More concerning is that the number of extreme heat days over 100 degrees is expected to increase from a historic 5 days per year to 69 days per year over that same time period. (de Campos Lopes & Tilman, 2020) Ensuring that our most economic-distressed and energy burdened households have access to energy efficiency and low-income solar programs are essential to build community resilience to climate change.

Charlottesville’s Gas Utility

An impressive number of 319 households in Charlottesville face an energy burden of 6% or higher due to natural gas consumption alone, all of which have household incomes lower than 30% of AMI. Although these hundreds of families would greatly benefit from energy efficiency improvements related to natural gas use, adding relevance to existing Charlottesville Gas energy savings programs and the potential creation of new ones, it is important to remark that this number only represents a small fraction of the City’s 4,067 households which face high energy burden due to electricity consumption alone. This suggests that energy efficiency upgrades for electric appliances may reach more residents and be more effective overall than natural gas-targeted upgrades in reducing Charlottesville’s overall energy burden.

Designing Smart Solutions

Significant environmental and social benefits could be achieved through a program targeted to households with the most extreme energy burden. Targeted solutions for highly energy burdened homes with high energy costs could focus on energy efficiency improvements, while highly energy burdened homes with efficient homes but lower incomes could focus on solar energy projects. Some homes would require a combination of both energy efficiency and solar.

To demonstrate what a targeted program could accomplish, C3 analyzed the results of a hypothetical program to reduce the energy burden of these households to an acceptable level of less than 6% by utilizing a combination of energy efficiency and solar.

Our analysis assumed that all energy burden is due to electricity consumption, that income levels are uniformly distributed within an income bracket, and that the program will benefit 1,000 households under one of two implementation criteria: (1) “first come, first served”; (2) “thoroughly targeted”. [1] [2]

TABLE 4	Climate and Social Impacts of Promoting Energy Equity (Charlottesville, VA)				
Year Built	**Average Energy Burden Level**	**Energy Saved per Year (kWh)**	**Income Saved per Year ($)**	**Freed Income (%)**	**GHG Emissions Avoided (Tons)**
Per Household					
Criterion 1	17%	7,000	808	11%	2.9
Criterion 2	24%	11,044	1,276	18%	4.5
Aggregate (1,000)					
Criterion 1	17%	6,999,548	808,448	11%	2,856
Criterion 2	24%	11,043,682	1,275,545	18%	4,506
Source:	Own elaboration based on data obtained from the U.S. Department of Energy's Low-Income Energy Affordability Data (LEAD) Tool and the U.S. Energy Information Administration (EIA).				

In this hypothetical example, summarized on Table 4, the City could free up to 18% of each beneficiary’s annual income, potentially

[1] Under the first criterion, the average energy burden of the program beneficiaries is equal to the average energy burden faced by the extremely-low income households (i.e. 17%). Under the second criterion, the average energy burden of the beneficiaries will be a weighted average of the highest energy-burdened households (i.e. 24%).

[2] The average income level of participating households is assumed to be the same under both criteria.

moving hundreds of households to affordable housing conditions by adopting a thoroughly targeted program. For example, reducing the energy burden of a household with an income of $15,000/year (or 19% of AMI) to 6% from 25% would save that household $2,850/year (following the illustrative values depicted on Table 5). Besides generating local jobs and reactivating the economy, a program like this could also reduce energy costs equivalent to up to 750 average local residential energy bills, while reducing GHG emissions equivalent to up to 850 Charlottesville households' average annual electricity emission.

TABLE 5	Hypothetical Estimation of Household Energy Costs, per Income Level and level of Energy Burden Level				
Income Level	**Burden of 3%**	**Burden of 6%**	**Burden of 10%**	**Burden of 20%**	**Burden of 25%**
$ 15,000 (or 19% of AMI)	$450	$900	$1,500	$3,000	$3,750
$ 23,340 (or 30% of AMI)	$700	$1,400	$2,334	$4,668	$5,835
$ 30,000 (or 39% of AMI)	$900	$1,800	$3,000	-	-
$ 37,500 (or 48% of AMI)	$1,125	$2,250	$3,750	-	-
$ 46,680 (or 60% of AMI)	$1,400	$2,801	$4,668	-	-
Source:	Own elaboration based on data obtained from the U.S. Department of Energy's Low-Income Energy Affordability Data (LEAD) Tool (values for 2016). *No households with energy burden of 20% or more had income higher than 30%.				

Energy Efficiency

According to the ACEEE, 35% of the excess energy cost-burden experienced by low-income families could be eliminated if energy efficiency improvements were made to bring low-income housing up to the efficiency level of the median U.S. home. Raising household energy efficiency to the median could eliminate 42% of excess energy burden for African-American households, 68% for Latinx households, and 97% for renters (Drehobl & Ross, 2016).[3]

Similarly, the U.S. Environmental Protection Agency (EPA) in 2018 estimated that homeowners could save $200 to $400 per year on their energy bills by making energy efficiency improvements, including sealing air leaks and upgrading air conditioning equipment.4 Thus, the U.S. EPA recommends that local governments simultaneously tackle the affordable housing crisis and reduce residential GHG emissions by designing energy efficiency programs for affordable housing and low-income populations (U.S. EPA, 2018).

Energy efficiency upgrade financing could dramatically improve the welfare of energy burdened households by reducing their annual energy costs. C3 considers it is important to observe, however, that the potential increase in property value and rent prices requires that policy makers implement well-designed energy efficiency policies in a way that promotes both energy and housing affordability, while protecting local residents from gentrification processes.

Low-Income Solar

Solar energy is being harnessed in an ever-growing effort to reduce household energy costs while foregoing the use of environmentally-harmful fossil fuels. According to the U.S. Department Of Energy, purchasing solar panels is favorable for households with high utility bills, living in sunny locations, qualifying for tax credits, or those seeking to increase home value (U.S. DOE, 2016). This could mean an opportunity for areas that received severely limited real estate investment over time, historically

[3] Excess energy burdens were calculated as the difference between category-specific median energy burdens and the all-household median energy burden. Categories were defined based on income level, race, or homeownership.

[4] Approximately 10%-20% of an average household energy bill in Virginia, according to the U.S. Energy Information Administration.

underserved urban areas, as they usually present fewer environmental amenities like urban-tree canopy.

Nevertheless, the Clean Energy States Alliance reported that while demand for solar energy in the United States has grown by 23 times between 2008 and 2016 and installation continues to become more affordable with falling prices, such energy solutions often remain out of reach for low- to moderate-income (LMI) households, highlighting the importance of proactive governmental measures to ensure an equitable access to this climate friendly technology (CESA, 2019).

With carefully designed policies, solar photovoltaic systems for LMI households can ease energy burden while improving health by diminishing exposure to pollutants, raising property value, and providing jobs to under-served communities. For instance, Charlottesville's GO Initiative (short for Growing Opportunities) developed a free job-training program to give local residents the required knowledge to work in the solar industry in partnership with Sun Tribe Solar. The GO Solar program was the first Charlottesville program in the renewable sector. After the program's conclusion, Sun Tribe Solar hired five of the GO Solar graduates, three African American, one Afghan national, and one white.

This is Just the Beginning

Improving housing livability is a policy priority for the City of Charlottesville and many other municipalities. Well-crafted, energy equity policies can reduce household energy burden and increase housing affordability by freeing up household's income currently allocated to overall housing costs. In addition, climate-friendly homes that benefit from higher energy efficiency and cleaner forms of energy, can improve health and contribute to a more sustainable future.

It is C3's hope that the information presented in this report will equip community stakeholders and decision-makers with a thorough

understanding of how to promote energy equity in communities like Charlottesville and provide important information to advocate for an equitable allocation of resources from current and forthcoming State and energy utilities efficiency programs.

C3 acknowledges that some important questions still need to be addressed by future studies, with the further collection of primary data, such as whether lower-income households have higher per-capita energy consumption or higher per square foot energy consumption.

It is also essential that subsequent energy equity programs are designed with community and stakeholder engagement before, during, and at the conclusion of program deployment. This will ensure that the programs will be successful and widely adopted. We hope that this report gives us a roadmap for where those conversations must begin.

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